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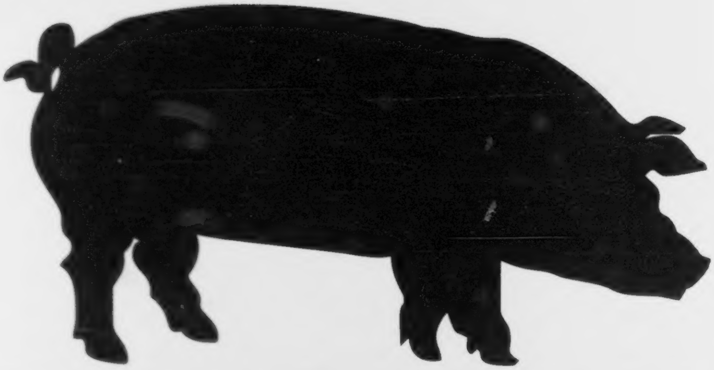

CENTRALIA SWINE RESEARCH UPDATE

January 25th 2012

CentraliaSwineResearch.ca

CENTRALIA SWINE RESEARCH UPDATE
Kirkton-Woodham Community Centre
January 25, 2012

9:00 a.m. REGISTRATION and COFFEE
9:50 Opening Remarks

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10:30 The Impact Of Inexpensive Nursery Pig Diets On Grower/Finisher Performance And Carcass Quality I-5
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10:45 PRRS Update I-7
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Adjourn

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Future Updates:

Wed. January 30, 2013

Wed. January 29 , 2014

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The Centralia Swine Research Update Planning Committee would like to acknowledge the logistical support from the Ontario Ministry of Agriculture Food & Rural Affairs for the co-ordination, proceedings and registration of this event.

Ontario

Video Imaging For Real-Time Performance Monitoring Of Growing-Finishing Pigs

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[1]Centre for Nutritional Modeling, Department of Animal and Poultry Science, University of Guelph and [2]Wallenstein Feed and Supply Ltd.

Take Home Message

Video imaging of growing-finishing pigs appears promising for non-invasive monitoring of growth performance, but further evaluation is required. Automated selection of appropriate images requires improvement in order to increase the correlation between actual body weights (BW) and BW estimates from video images. Identification of animals should be incorporated to control the variation in contribution of individual pigs to mean pen body weight estimates. Development of specific algorithms may be required to account for gender and genotype effects on the relationship between video images and BW.

Background

Knowledge of daily growth rates of pigs allows producers to optimize nutritional management practices, predict and control shipping weights, and assist in monitoring herd health. Even though historical performance is often not indicative of future performance, nutritional management of growing-finishing pigs is typically based on retrospective analysis of historical growth performance. The latter reflects limitations of conventional data collection methods for real-time monitoring of pig growth performance. Video image analysis (VIA) uses aerial-view images of animals to determine body surface dimensions and may be used for real-time and continuous monitoring of pig growth performance. Qscan is a VIA system that is available for commercial use in growing-finishing pig units in the United Kingdom.

Objectives

The goal of this research is to provide an assessment of Qscan in the Canadian swine industry. The main objectives are to assess the ability of Qscan to accurately and precisely estimate: (1) live BW of individual pigs, and (2) mean BW for groups of growing-finishing pigs.

Trials Completed

The first study examined the ability of Qscan to estimate weekly BW of individual and pens of pigs in a research setting. A total of 96 purebred Yorkshire pigs in 12 pens were monitored over a 6 week period between 50 and 92 kg BW in a 2 x 2 factorial design, allowing assessment of the effects of gender (barrows vs. gilts) and feeding ractopamine (0 vs. 5 ppm) on the Qscan system's precision and accuracy.

The second and third study examined the ability of Qscan to estimate weekly mean pen BW of pigs in commercial facilities. In the second study, 120 Hypor x Genesus pigs (15 barrows and 15 gilts per pen) were monitored over a 14 week period between 36 and 108 kg BW.In the third study, 240 Hypor x Danbred pigs (4 pens with 30 barrows and 4 pens with 30 gilts)were monitored over a 12 week period between 36 and 108 kg BW.

All pens of pigs were continuously monitored using the Qscan system and all pigs were weighed individually at weekly intervals using a conventional weigh scale in all three trials.

Results to Date

In trial 1 and based on measurements on individually identified pigs in week 1 and 6, there was no difference between mean actual (scale) and Qscan estimated BW; there was no bias due to gender or feeding ractopamine. Actual and Qscan estimated mean pen BW differed in week 3 only. The accuracy of Qscan differed between genders, with interactions between gender and methods for determining BW occurring in weeks 2 and 3. Throughout the study, the difference between actual and Qscan estimated mean pen BW was less than 1.46 kg for gilts. On average Qscan overestimated mean pen BW of barrows by 3.51 kg for weeks 1 to 4, but was within 0.45 kg of actual mean pen BW for weeks 5 and 6.

In trial 2, actual and Qscan estimated mean pen BW differed in weeks 1 to 5, with an average difference of 4.91 kg over the five week period. Actual and Qscan estimated mean pen BW did not differ in weeks 6 and 8 to 14, with an average difference of 1.33 kg over the 7 weeks.

In trial 3, actual and Qscan estimated mean pen BW differed in weeks 1 to 5 and 7 to 9, with estimates within 3.33 kg of actual weight over these weeks. Actual and Qscan estimated mean pen BW did not differ in week 6, or 10 to 12, with estimates within 1.35 kg of actual weight for each of these weeks. The accuracy of Qscan differed between genders in week 8 only. During this time, Qscan overestimated mean pen BW for barrows by 2.28 kg, while underestimating mean pen BW for gilts by 0.07 kg.

Additional Observations and Future Considerations

Filtering of images requires improvement. The contribution of poorly outlined images, and their resulting poor quality weight estimates were found to have an effect on system accuracy in some cases. Up to 60% of images reviewed were found to be improperly outlined. Removing these poor quality images resulted in stronger correlations between actual and Qscan weight estimates.

Variation in the number of weight measurements of individual pigs relative to the total number of images per pen contributes to the discrepancy between Qscan estimated and actual pen mean BW. In extreme cases the contribution of individual animals varied from 1.76 to 33.53% of total images. Incorporating individual identification into the Qscan system should be considered.

Differences in the accuracy of Qscan estimated BW for gilts and barrows were found in Trial 1, but were not as significant in Trial 3. These different findings may be explained by differences in body shape, which were observed between barrows and gilts in Trial 1, but not in Trial 3. In Trial 1 barrows were found to have larger shoulders and gilts were found to have larger hams as an overall proportion of their body area. Differences in the mass of the shoulder and ham sections of the body could be contributing to the differences seen. Separate algorithms may be required to account for gender and genotype effects on relationships between area and actual BW.

Acknowledgements

Financial support for this research is provided by Agriculture and Agri-Food Canada, the Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA), Ontario Pork and Wallenstein Feed and Supply Ltd.

Evaluating the Use of a Dehumidifier in a Swine Finishing Barn to Improve Air Quality for the Benefit of Hogs, Producers and Barn Equipment

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[1] Ontario Ministry of Agriculture, Food and Rural Affairs
[2] Ontario Pork

Why control humidity in a Swine Barn?

Humidity in swine facilities is a produced primarily from the animals respiration and evaporation from the slats surfaces and the surface of the liquid manure storage. A 50 kg feeder pig housed on total slats, produces an average of 80g of water vapour per hour. If not removed by ventilation this vapour will soon increase well in excess of the 70% maximum which encourages the growth of molds and mildews. The condensation will also deteriorate the barn structure and mechanical components. High humidity levels are an indication of insufficient air exchange. Proper ventilation is required to dilute gases such as Ammonia, Hydrogen Sulphide, Carbon Dioxide, dusts and disease organisms present in the barn space.

How we normally remove moisture from a Swine Barn?

Moisture is normally removed from the barn in the cold weather by bringing air into the barn space, as this incoming air warms from the heat from the animals and often supplemental heat it expands in volume, thereby reducing its relative humidity. The air then circulates around the room absorbing moisture, gasses and dust and is exhausted to the outside. The challenge in Ontario is that during the winter many producers in order to save on supplemental heat reduce the ventilation rate. The room temperature remains the same but the relative humidity climbs above 70% and beyond along with a corresponding increase in concentration of the aforementioned gases, dust and disease organisms present in the room and a reduction in oxygen.

Why not use a dehumidifier commonly used by other industries?

Dehumidifiers used in residential and commercial/industrial settings consist of a refrigeration unit powered by an electrical motor. Air from the room is blown over the coils on cold side of the heat pump. As the air is chilled the relative humidity increases to the dew point at which time moisture is removed as condensation. For swine barns humidity control is only one part of improving overall air quality. Dehumidifiers do nothing to remove gases or disease organisms. As a 50 kg feeder pig on total slats produces 80 g of water vapour per hour, the amount of electricity required to remove even a portion of this moisture with a traditional dehumidifier quickly becomes very expensive. Most of these units were never designed to work in the corrosive environments of a swine barn and suffer reliability issues in such environments.

How does a Heat Exchanger work to control humidity?

Heat exchangers in themselves do nothing to remove moisture. Heat exchangers function to transfer energy from the outgoing air to the incoming air. By using plates or tubes arranged to maximize surface area between the two airstreams and materials that have high conductivities the energy from the outgoing air transfers to the cooler incoming air. The greater the temperature differential, the greater the energy flow between the two airstreams. As the incoming air is now warmer the need for supplemental heat is reduced or can even be eliminated depending on the building insulation levels, outside air temperatures and the animal class. Minimum ventilation levels can be increased without incurring a large financial penalty from increased heating costs. It is the increased air exchange that results in increased moisture removal.

Why early Heat Exchangers fell out of favour?

Earlier heat exchangers were often constructed of parallel flat metal plates, often aluminum. While a very efficient design for most environments, in a swine facility issues with corrosion from barn gases and dust, fouling from dust and ice buildup during extreme cold events that required constant cleaning and maintenance on behalf of the producer caused them to fall out of favour. Air distribution was also a problem in that many models had no way to easily distribute the incoming air evenly throughout the room.

Progress to Date

In the Fall of 2011 a RECOV-AIRE air to air Heat Exchange System was installed in one 240 head room swine finishing facility consisting of 4 rooms of 240 head each. This unit has been designed to specifically address the issues around cleaning, maintenance of the unit and air distribution. In the room with the heat exchanger the existing heater was removed. All the rooms are being monitored for temperature and relative humidity. There are electrical meters to monitor electrical use in each room as well and all pigs are weighed going in and out of the room. To date due to the warm whether the there is little preliminary results. It is hoped as the winter progresses during a prolonged cold spell, maximum daily of -10C° for 3 consecutive days or more will allow for results reflecting a more realistic winter time conditions.

Who's supporting this project?

Kraaybrink Farms located in Moorefield is the farmer cooperator. Ontario Pork and the Farm Innovation Program are overseeing the project with funding provided by the Agricultural Adaptation Council. OMAFRA is providing technical support, data collection equipment and data analysis.

Resources

OMAFRA, 2010, Ventilation for Livestock and Poultry Facilities, Publication 833

The Impact Of Inexpensive Nursery Pig Diets On Grower/Finisher Performance And Carcass Quality

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Introduction

The relationship between growth performance in the nursery and of the growing-finishing pig is a subject of considerable debate but of great practical relevance. The common view suggests that compromised growth in the nursery reduces overall performance up to market weight; however, recent work in the UK indicated that reduced weaning performance due to a lower quality diet does not influence subsequent growth performance (Wellock et al., 2007, 2009). Nelssen et al. (1999) suggest that compensatory growth is more likely to occur when nutrient intake is restricted and less likely to occur when diets are fed that are likely to compromise pig health, i.e. diets that contain no antibiotics or relatively large amounts of soybean meal.

Methodology

A performance study was conducted with 96 pigs in each of 5 blocks to test the effect of compromised post-weaning growth on growth performance in the growing-finishing phase and carcass characteristics at market weight. During the starter phase (28 – 70 d of age), pigs were fed 1 of 4 test diets: complex (C; highly digestible ingredients) or simple (S; corn and soybean meal) with (A+) or without (A-) in-feed antibiotics (273 g chlortetracycline/100 kg diet). All pigs received identical diets during the growing-finishing phase. Body weight, feed intake and feed efficiency were calculated on a weekly basis in the nursery phase and every 2 weeks in the growing-finishing phase. In subsamples of pigs, digesta and tissue samples were obtained to better understand how diet impacts the pigs' physiology. At 110-115 kg BW, pigs were slaughtered and graded according to the Canadian grading system.

Results

There was little interaction between diet and antibiotic inclusion for growth performance in either the nursery or growing-finishing phase. Diet complexity and in-feed antibiotics increased body weight ($P< 0.05$) from Phase 1 to 3.ADG was lower ($P < 0.05$) for S than C in Phase 1(92 vs. 132 g/d) and Phase 2 (420 vs. 453 g/d).Feed intake was lower ($P< 0.05$) for S than C in Phase 1 to 3 (836 vs, 887 g/d). Gain:feed was lower ($P<0.05$) for S than C in Phase 1(0.48 vs. 0.59) and Phase 2 (0.75 vs. 0.79) but higher ($P=0.04$) for S than C in Phase 3 (0.57 vs. 0.55).ADG was greater ($P<0.05$) for A- than A+ in Phase 1 to 3 (505 vs. 538 g/d). There was an interactive effect ($P = 0.03$) on feed efficiency in Phase 3 (0.56, 0.55, 0.56, and 0.59 for C-, C+, S-, and S+, respectively). In the proximal jejunum, villus height was lower ($P = 0.03$) at wk 2 in pigs fed the simple diet (356 vs 427 μm) but not different at wk 4 (527 vs 492 μm). There was no difference in crypt depth but villus height:crypt depth ratio increased ($P = 0.04$) from wk 2 to wk 4 (1.7 vs 2.2) in pigs on L and did not change in pigs on H (2.4). Pigs on C tended to have a greater ($P< 0.17$) proportion of proliferating cells in the jejunum at wk 2 and 4. During the GF phase, pigs on A- grew faster ($P<0.05$) than pigs on A+ (1071 vs. 1029 g/d). There were no treatment effects ($P>0.1$) on G:F for the overall experimental period. At slaughter, there were no treatment effects ($P>0.1$) on loin eye area, fat depth, estimated carcass lean yield or days from weaning to slaughter. Disease challenge during the nursery phase in the last of the 5 blocks resulted in reduced weaning growth performance and appears to have increased days to market; although, not all pigs have reached market weight in this block at the time of this report.

Implications

These results show that feeding antibiotic-free and low complexity diets compromises growth performance during the starter phase, but induces compensatory growth thereafter and has no long-term effect on growth performance in the growing-finishing phase, days from weaning to market or carcass characteristics. Therefore, a reduction in feed costs may be obtained in the nursery phase by feeding less complex diets without compromising subsequent growth performance and carcass value; however, pigs fed simple diets during the nursery may be less robust and hence more susceptible to disease. More work is needed to understand the effect of reduced cost nursery pig feeding programs on overall pig performance including disease resistance.

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PRRS Update

Zvonimir Poljak, Hien Le, Robert Friendship, Rob Deardon, Cate Dewey
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For a long period of time, PRRS has been considered primarily a production-limiting disease, and as such a disease of primary interest for individual producers and for their herd veterinarians. Several factors have contributed to a change in attitude toward this disease in recent times. Emergence of novel, sometimes highly pathogenic, strains have been observed in some North American swine populations and the annual cost of PRRS in Canada has recently been estimated at $130M. At the same time, successful control of PRRSV has been reported as well, either at the level of entire industries or at the level of geographical regions. Such developments led to the initiation of regional PRRSV control programs in Canada as well. An important step toward regional control is to have in place methods, strategies, and approaches for disease elimination at the herd level. In addition to field observational studies, clinical trials, and program evaluation, mathematical modeling is considered to be a good tool to help understand the dynamics of infectious diseases in a population. They might also help to evaluate the effects of infection control strategies under simulation conditions. The advantage of this strategy is that it can use the diagnostic data that are being collected as a part of regular monitoring and outbreak investigation, and that it can utilize these data in a simulation model without excessive cost and under a variety of assumptions; an approach that would not be possible under field conditions. This is of particular relevance for PRRSV, because many interventions for PRRSV control are applied at the herd- or even system-level. The objectives of this study were to estimate parameters important for understanding PRRSV infection dynamics in Ontario herds using observational data and to gain qualitative understanding of PRRSV dynamics when common infection control practices are applied alone or in combination. The latter objective was addressed by building simple deterministic mathematical models. The observational data included results of a PRRS enzyme-linked immunosorbent assay (ELISA) on blood samples from nearly 800 piglets sampled longitudinally from seven swine herds in Ontario. A random effect linear model was used to estimate the decay of maternal immunity, and random effect Poisson regression was used to estimate a transmission parameter. Based on the parameters estimated from the data and additionally obtained from the literature, the production-stage structured deterministic mathematical model for sows and the age-structured model for nursery pigs were built to include herd demographics and dynamics of PRRSV infection. The herd was assumed to be completely susceptible and was seeded with one infectious sow. Further assumptions were built into the model as well. Control strategies included gilt acclimatization, herd closure, and mass immunization in different combinations. The important findings from this study will be discussed. In addition, extension of similar principles to the regional and also industry level will also be discussed.

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Farmscape online: http://www.farmscape.ca, November 1, 2010 (Episode 3447)

Investigation of the Use of Meloxicam for Reducing Pain Associated with Castration and Tail-docking in Piglets

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Glen Cassar DVM, PhD, DipABVP
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Reason for the study

Practical methods of pain control are becoming available in the area of livestock production. For example, analgesics such as meloxicam, a relatively long-acting non-steroidal anti-inflammatory (NSAID), are becoming licensed for food animals. This provides an opportunity to address a major welfare concern regarding the swine industry's need to perform certain painful surgical procedures on piglets such as castration. At present it is common practice not to provide anaesthetic or analgesia. With the introduction of a new drug it is important to conduct research trials to ensure the product is safe and efficacious. Efficacy is particularly difficult to assess with regard to pain control in pigs. Anyone who has observed a litter of piglets during the hours or days foll9owing castration knows how difficult it is to distinguish the castrated pigs from the female litter mates based on behaviour and performance.

The objective of this trial was to determine the safety and efficacy of using meloxicam to reduce the post-operative pain associated with castration and tail-docking.

Materials and Methods

The study used 407 litters and included 3,944 piglets (1,990 males and 1,954 females). All piglets were randomly allocated to receive a single intramuscular injection of one of the following treatments at least 30 minutes prior to castration and tail docking: injection of 0.4 mg/kg bodyweight meloxicam, injection of 0.4 mg/kg bodyweight placebo, or no injection (control). Piglets were weighed at castration and tail-docking at 5-7 days-of-age and at 19-21 days-of-age prior to weaning. Mortality data were collected daily. Piglet vocalizations were measured during castration on 150 male piglets. For 30 minutes immediately following castration, piglet behaviour was observed on a total of 15 litters and 143 piglets. A total of 360 blood samples from 40 litters were collected from piglets at 30 minutes, 60 minutes, 90 minutes, and 4 hours post-castration for determination of plasma cortisol concentrations. The data analysis from the present study on plasma cortisol levels and behaviour is ongoing.

Results

There was not a significant difference between treatment groups with respect to average daily gain (ADG). Piglets grew an average of 167.9±60.3g/day when receiving meloxicam and 164.6±63.2g/day when receiving the placebo (P=0.44). Maximum ADG values of 420g/day when receiving meloxicam and 440g/day when receiving placebo were observed. There was not a significant difference between treatment groups with respect to mortality rate with 3.18±0.16% mortality in the meloxicam group and 3.84±0.19% mortality in the placebo group (P=0.33). Gilts whether receiving meloxicam or not grew at a similar rate to barrows. The analysis of the more detailed studies determining reaction to pain is pending.

Discussion

It can be concluded that meloxicam did not cause any negative effects based on the growth rate and mortality results and we conclude that it appeared to be a safe analgesic to use in young piglets. Production performance is not an adequate measure to determine if meloxicam was effective in reducing post-operative pain associated with castration in that castrated pigs whether receiving meloxicam or not grew as well as non-castrated litter mates.

At present there are no ideal methods of measuring the effectives of pain control. Blood cortisol levels are often used but they may become elevated as a result of stresses such as handling. Behaviour is also generally monitored and used in assessing pain but measurements tend to be subjective. The observers must be "blind" to the treatment. The observational results tend to be difficult to assess because there is so much individual variation.

The take home message from this work is that producers will need to consider using pain control as part of their standard operating procedures in order to meet their costumers expectations and fortunately there will likely be products becoming available that will meet these needs.

Acknowledgements

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Benchmarking Farrow to Finish Farms – What Have We Learned?

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Background

The Ontario Data Analysis Project (ODAP) has been conducted by University of Guelph, Ridgetown Campus since 1991. It is a benchmarking study based on financial and production data from farrow to finish farms in Ontario. Participants that provide information receive a personalized farm analysis that compares their farm data to the group average. The farms that are involved have about 100 to 500 sows and it is believed that the results generated are fairly representative of a farm this size.

Results

The results are on a "pigs produced"/sow basis. This reflects the number of market hog equivalents produced on the farm and it takes into account all production and inventory changes. Table 1 shows the group averages of some key productivity variables for the previous six years. The average number of sows during this time period was between 207 and 230. The data indicates that productivity has increased over time with pigs weaned/litter increasing by 0.6 pigs.

Pre-weaning mortality has been fairly consistent over time but weaner and grow-finish mortality were quite high in 2005 and 2006 respectively likely due to disease challenges. Pigs produced/sow/year improved by 20% from 2005 to 2010.

Table 1 - Productivity over Time

Group Average/yr	2005	2006	2007	2008	2009	2010
Litters/sow/yr	2.3	2.3	2.3	2.2	2.3	2.3
Weaned/litter	9.4	9.4	9.0	10.1	10.2	10.0
Weaning age	22	22.3	23.9	24.3	23.6	23.2
Pre-wean mortality %	11.7	11.4	11.9	11.6	11.0	10.9
Weaner mortality %	11.5	4.6	4.6	4.0	3.3	2.6
Grow-finish mortality %	3.3	8.4	4.0	3.2	2.4	2.8
Pigs produced/sow/yr	16.8	17.9	17.8	20.0	20.9	20.2
Days to market	166.0	167.1	169.3	165.3	165.5	165.2

Table 2 shows how some expenses have changed from 2005 to 2010. Feed expenses are particularly noteworthy. During the most recent four years (2007 to 2010) feed was about \$10 to \$22/pig produced higher than in 2005. The "perfect storm" of high feed prices, low hog prices, COOL legislations and the strengthening Canadian dollar that occurred during the 2006 to 2009 timeframe took its' toll on producers as shown by the especially low current ratio (current assets ÷ current liabilities) in 2009 (i.e. 1.27). As well, the debt to asset ratio was highest in 2009 since most producers had to assume more debt to finance their operations. For 2010 the current ratio was stronger and the debt to asset ratio was a bit lower.

Table 2 – Expenses and Financial Ratios

$/pig produced	2005	2006	2007	2008	2009	2010
Feed	83.41	78.15	95.36	105.19	93.92	96.19
Health	5.85	5.39	5.67	4.32	4.74	4.57
Interest	11.3	10.38	9.24	6.84	8.23	7.48
Utilities	4.57	4.63	4.69	4.37	5.20	6.14
Current ratio	1.82	1.50	1.56	1.79	1.27	1.88
Debt/assets	0.33	0.33	0.36	0.35	0.42	0.40

The benchmark information above is helpful in getting a general sense of where things are at in the industry. However, in order to be competitive it is also beneficial to compare to the top producers. Table 3 shows results for the average of all farms and the average for the top half of the producers for the 2008 to 2010 time period. Farms were sorted by net farm income for the whole farm and included family labour expense. What is important to note is that productivity is very similar between the average of all farms and the average of the top half of farms. The top half of farms did have lower mortality at all stages of production. However, the biggest difference occurs in cost control. The top half of farms had $9.76 lower expenses per pig produced.

Table 3 - Difference Between Average of All Farms and Top Half of Farms 2008-10

	Top ½ of Farms	Average of All Farms	Difference Top - Average
Litters/sow/yr	2.2	2.3	-0.01
Weaned/litter	10.00	9.94	0.06
Pigs produced/sow/yr	20.10	20.03	0.07
Pre-wean mortality	10.3%	10.7%	-0.4%
Weaner mortality	3.1%	3.3%	-0.2%
Grow-finish mortality	2.2%	2.8%	-0.6%
Expenses/pig produced			
Feed	97.93	100.50	-2.57
Health	4.17	4.61	-0.44
Interest	5.40	7.09	-1.69
Utilities	5.12	5.41	-0.29
Total expenses	140.55	150.31	-9.76

Key Points

It is important to have access to benchmark information to understand how competitive your farm is. It can highlight areas of your farm that are performing well and areas where improvements could be undertaken. Being able to compare your farm to a group or industry average is the first step but then trying to be as good as the top producers will further improve the chances of profitability and competitiveness. Productivity has been improving over time but controlling costs is a critical factor in farm profitability.

Acknowledgements

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How to Mitigate the Effects of Feeding DDGS on Carcass and Pork Quality

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At typing the title above, it reads like I will be providing insight into how to lessen the effects of something that we know affects carcass and pork quality, yet we feed it anyway. It is worth to stop and think how we got here and why we are still feeding it. Pork producers were just doing fine feeding low-cost cereal grains. But it was hard relying on foreigners to provide oil (gasoline), so why not derive a portion from corn alcohol. Subsidies to produce ethanol started and consequently distillers dried grains with solubles (DDGS) became available to feed to livestock. Pigs being a marvel beast grew well feeding on them, and some pushed feed inclusions up to 65% of the diet. This paper focus on how to mitigate the effects of feeding high inclusions of corn DDGS to hogs on carcass traits and pork quality.

Effect of Feeding DDGS on Carcass

To clarify, the effect of feeding DDGS is most evident on dressing percent instead of on carcass traits except lean. Corn grain is high in starch content. When enzymes are added to breakdown the starch, and yeast ferment its sugars to ethanol, the remaining non-starch sugars (polysaccharides), which is mostly nonsoluble fibre, concentrate about 3-fold as the starch is depleted. The pig produces no digestive enzymes to breakdown this fibre. Instead the pig relies on microbes in the hindgut to partially breakdown the fibre in DDGS before the undigested portion (~23% vs. 10% in corn grain) is excreted. To compensate for the higher fibre content of DDGS diets, the pig's gut thickens and increases in size (capacity). When hogs are eviscerated at slaughter, the guts weigh more and hold more digesta, reducing the weight of the carcass proportionally in relation to live weight (dressing percentage).

To mitigate the effect of feeding high levels (30%) of DDGS on dressing percentage, we have concluded that it is necessary to withdrawal DDGS from the finisher diet for ~3 weeks (Figure 1). It is also necessary that hogs have a fasting period without access to feed for 16 – 24h before slaughter. At least part of this fasting period should be tranquil as the stress of transport and pigs fighting can delay digestion. The effect of feed fibre on reducing dressing percent is not only limited to feeding DDGS, but also occurs feeding other fibrous feedstuffs (e.g. canola meal), even barley instead of wheat or corn grain.

Effects of Feeding DDGS on Pork Quality

That explained above for fibre concentrating ~3x as starch is depleted also applies to other nutrients. Corn grain also has a relative high content of oil (~4%) that concentrates ~3x in DDGS (11%). Most of the oil in corn DDGS is linoleic acid, a type of unsaturated fat. Because pigs have long been selected to reduce fat deposition, the type of fat they lay down reflects the fatty acid composition of what they feed. It has been long known that when hogs consumed unsaturated fats, their lard softens. That is the case when feeding corn DDGS at high dietary inclusions (>15%) and the incidence is worsen feeding diets based on corn grain. Corn grain has slightly higher (2-3%-units) oil content that wheat or barley.

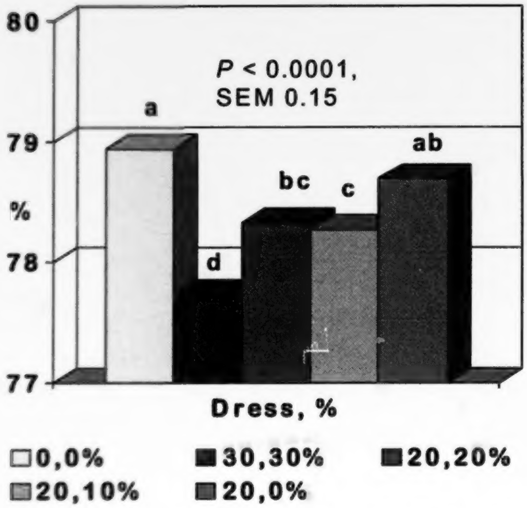

Figure 1. Withdrawal of corn DDGS from the finisher diet (20, 0%) for the last ~3 wks of the growout period corrected the reduction on dressing percentage induced by this fibrous feedstuff.

Bacon is the most affected pork cut by feeding unsaturated fats to hogs. The belly is the primary abdominal fat depot. Packers complain that 'fluffy' bellies are more difficult to slice, bacon slices stick together instead of separating easily, and consumers say the bacon appears mushy. Packers also allege that loins are softer and less appealing to Asian consumers who prefer light-cooking thinly sliced pork. Our research results indicated that a consumer panel could not discern between cooked loin chops or burger patties of hogs fed either 0 or 30% corn or wheat DDGS. However, a separate consumer panel was able to discern breakfast sausage from hogs fed either 0 or 30% corn or wheat DDGS, but only when the sausage contained >30% pork fat. The same panel could not discern among cooked ham with <15% fat from hogs fed either 0 or 30% corn or wheat DDGS.

The same strategy suggested above, withdrawing DDGS from the diet for ~3 weeks to correct the reduction in dressing percent, was also effective improving pork fat hardness (Figure 2). Although it did not restore fat hardness (iodine value) to that observed in controls fed no DDGS, it did improve it to the extent that neither packer nor consumer could likely notice the difference that we were still able to establish with chemical analysis and sophisticated instrumentation. Gilts have less body fat than barrows and are affected to a greater extent by feeding them unsaturated fats. A longer withdrawal period is therefore recommended when feeding barrows and gilts separately.

There were other minor effects of feeding corn DDGS on pork quality, but these were of less practical significance than fat hardness. Feeding DDGS reduced the amount of intermuscular fat in each of the four primal cuts (picnic, butt, loin and ham) and all four primals combined. This finding concurred with slightly greater loin depth determined at carcass grading. Feeding 30% corn DDGS enhanced loin chop darkness and reduced both drip loss and the proportion of intramuscular fat (marbling), while increasing shear force values. In view of the recent change in packer preference seeking greater intramuscular fat (marbling) in loins, feeding 30% corn DDGS thus induced the opposite trend. This trend was somewhat reversed by implementing the 3-week corn DDGS withdrawal strategy, but did not entirely corrected it.

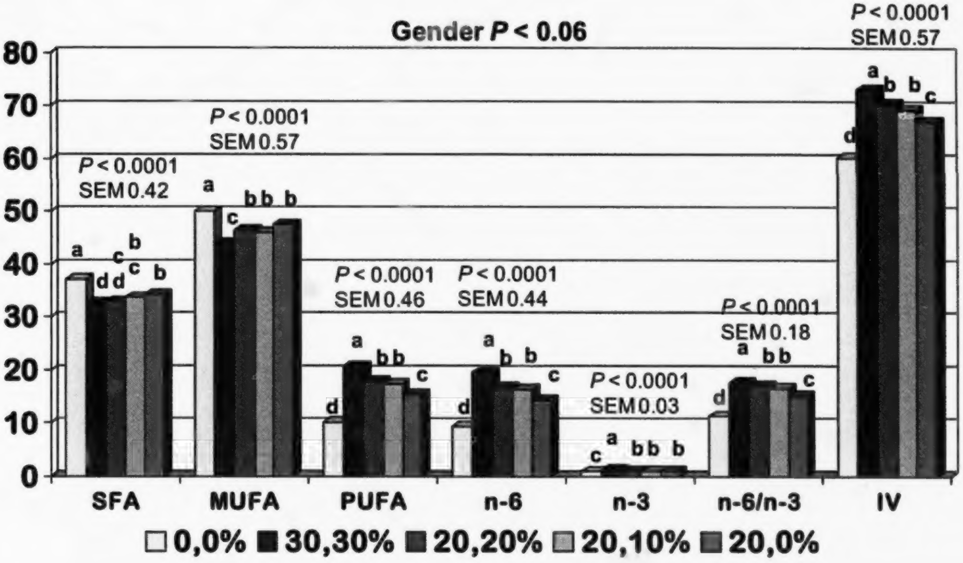

Figure 2. Feeding corn DDGS reduced saturated- (SFA) and mono-unsaturated fatty acids (MUFA), but increased poly-unsaturated, omega-6 and -3 fatty acids in belly tissue. Withdrawal of corn DDGS from the finisher diet for ~3 weeks, improved iodine value (67 in 20,0% vs. 72 in 30,30%) but it did not restored it to that of controls fed no DDGS (0,0%).

In conclusion, withdrawing corn DDGS from the finisher diet for the last ~3 weeks of the growout period corrected the reduction in dressing percentage induced by feeding this fibrous feedstuffs and lessen the softening of belly fat. Recent processing steps resulting in the removal of a portion of the oil from corn DDGS will improve pork fat hardness; however, it will make feeding corn DDGS less economically feasible. Pork producers and nutritionists generally have more economic sources of dietary lysine, so we feed corn DDGS primarily for its dietary energy value and digestible phosphorus content. Reduced oil content in DDGS equals less dietary energy. Producers thus need to focus and compare DDGS on cost $/Mcal of Net Energy (NE) to decide to source and stock corn DDGS.

Save $ with New Feeding Standards for Sows

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In the last few years, our new research in sow nutrition has provided evidence that the traditional feeding regimen of gestating sows needs revision. In particular, the increase in amino acid (AA) requirements from early to late gestation and the energy deficit of young sows in late gestation indicate that phase feeding of pregnant sows is necessary to fully meet their requriements. Experimental data from our research group cover the requirements in early and late gestation for lysine (Samuel et al., 2010), threonine (Levesque et al., 2011a), isoleucine and tryptophan (Moehn et al., 2012 a,b). Amino acid requirements were determined using the indicator AA oxidation technique simultaneously with indirect calorimetry to measure energy expenditure.

Table 1. Lysine[1], threonine, tryptophan and isoleucine requirements of gestating sows

		1st parity	2nd parity	3rd, 4th parity
Lysine	Early/late gestation	15.0/18.0	13.1/18.4	8.1/13.0
Threonine	Early/late gestation	n/a[2]	7.0/13.6	5.0/12.3
Tryptophan	Early/late gestation	n/a	1.7/2.6	n/a
Isoleucine	Early/late gestation	n/a	n/a	3.6/9.7

[1]Srichana (2006) for 1st parity, [2]not available

Table 1 shows requirements were always greater in late than in early gestation, regardless of AA studied or parity of the sows. Secondly, the AA requirements always decreased as sows aged, regardless of AA studied or stage of gestation. The more than 2-fold differences in AA requirements make it impossible to feed all sows to their requirements using only one diet.

Energy expenditure of sows changed little during early gestation but increased significantly (+0.2 MJ/d SE 0.04) in late gestation, so that sows fed a constant feed allowance in pregnancy had negative energy balance in the last quarter of pregnancy. We found that sows had positive energy balance in early and mid gestation, but negative energy balance in the last quarter of pregnancy. Although this applied to all parities studied, older sows had less negative energy balance than younger sows. To achieve energy equilibrium, older sows need less additional feed in late gestation than younger sows. Because the sows maintained good condition despite the late gestation energy deficit when offered a constant feed allowance, early gestation feed can be reduced significantly in a phase feeding regimen. When feed allowances in early gestation are reduced by 10%, the phases of constant and increasing heat production intersect on day 85 of pregnancy. Therefore, we need to use early gestation feed allowances from breeding to day 84 of pregnancy, and late gestation allowances from day 85 to entering the farrowing room.

To control body condition, pregnant sows are fed restrictively. Therefore, energy intake is the limiting factor for gestating sows and, thus, the feed allowance to provide the necessary energy must to be considered first when devising a sow feeding regimen. Generally, the feed allowance of sows is based on body weight and sow condition so that heavier and leaner animals are given more feed. For the purpose of this recommendation, ideal body condition is assumed.

Starting with typical feed allowances for the University of Alberta sows, a phase feeding regimen can use 10% less feed from day 1 to 84 of pregnancy (Table 2). Based on energy expenditure, we calculate that the feed intake of corn-based diets should be increased in late gestation by 600 g/d for gilts, by 500 g/d for 2nd parity sows and by 400 g/d for older sows. The mean daily feed intake of sows is a little less with phase feeding (Table 2) because of the lower feed allowances in early gestation. The necessary AA concentrations for this parity segregated phase feeding regimen range from 1.0% lysine for late gestation gilts to 0.34% lysine for early gestation older sows.

Table 2. Suggested daily feed intake (kg/d) of a corn-soybean meal based diet for average sows in good condition in early and late gestation.

	1st parity	2nd parity	3rd parity and older
Early gestation (day 1 to 84)	1.8	2.2	2.4
Late gestation (day 85 to 112)	2.4	2.7	2.8
Average daily feed:			
Phase feeding	1.95	2.32	2.50
Constant allowance	2.00	2.40	2.50

To achieve a segregated phase feeding system, the ideal implementation is to blend two diets covering the greatest and lowest requirements to meet the needs of pregnant sows of all ages, stages of gestation and body condition. The parity-segregated phase feeding reduces feed cost because excess nutrient intake is avoided as is excessive feed allocation, e.g. in early pregnancy. The feed cost savings alone may exceed $10 per sow and year. Generally the savings are greater for older sows and for periods when the cost of protein (i.e. soybean meal) is higher. In addition to the feed cost savings, parity segregated phase feeding may offer production advantages like better rebreeding of gilts, more robust piglets, more even piglets within litters and improved sow longevity.

In conclusion, switching to parity-segregated phase feeding of sows will save feed costs by supplying nutrients in the right amounts at the right time. Other economic benefits are currently being identified in an on-farm trial.

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Novel Techniques To Assess Lameness And To Evaluate The Effect Of Analgesia

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Background

Lameness has long been recognized as an economic and welfare problem in reproductive herds. In Canada 10 to 14% of removed sows are attributed to locomotion problems however, it is suspected that lameness is often underestimated or detected belatedly, such that its real prevalence and cost to farms is uncertain. Retention of lame sows also poses a welfare concern because lameness causes inflammation and pain that may impact feed intake, productivity and reproductive performance.

Currently, lameness detection is based on various visual locomotion scoring systems which are subjective, leading to variable results. Developing novel objective quantitative methods to assess lameness will provide a better understanding and detection of lameness. In addition, interest in the use of analgesics on lame sows to reduce pain is not well documented. Research in this area is necessary and may provide a means of improving welfare and productivity on reproductive sows.

The objective of this project is to estimate the relationship between different lameness indicators including a qualitative gait observation method with the quantitative accelerometer and kinematic methods. A subsequent study will determine the effect of analgesia in lame sows using the same lameness evaluation techniques. This project is part of the Canadian Swine Research and Development Cluster Project evaluating risk factors, assessment techniques and the effect of lameness on productivity and longevity of group and individual gestating sows and involves multiple collaborators.

Methods

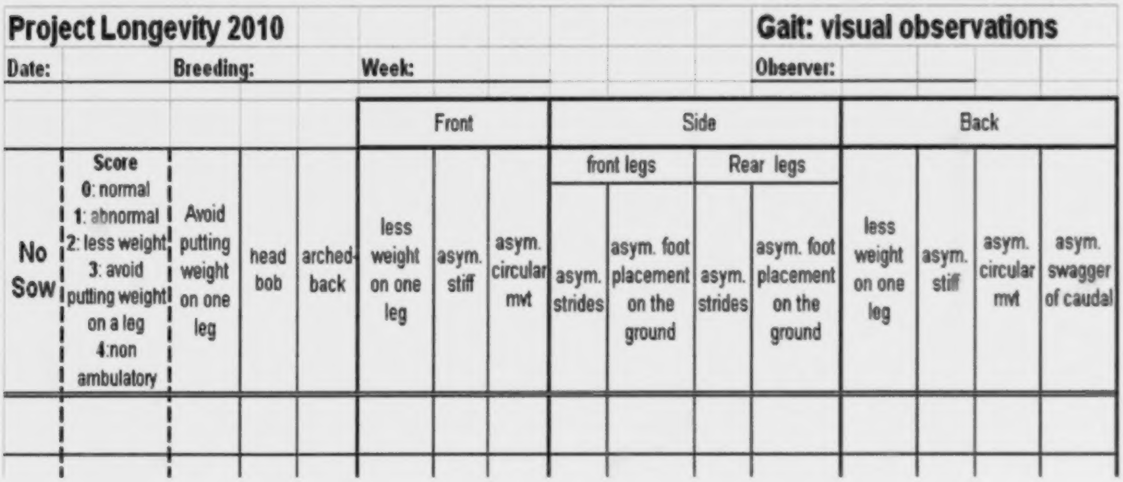
Assessment of gait

- **Visual observation:** using a scoring system of 4 scores considering gait movement, weight bearing; asymmetric strides, foot placement on the ground or swagger and stiffness of front and rear legs.
- **Kinematics:** use of markers located at specific anatomical points on the sow, while it is being filmed. The sow movement is computerized to assess the changes in body segments position during a specific time. Many variables of the stride's full cycle can be calculated: distance, speed, angles, elevation, swing, stance time and symmetry

Assessment of standing posture and stepping behaviour

- **Accelerometer (Hobo® data logger)** consists of a sensor with an embedded digital accelerometer that assesses:
  - **Posture**: The change of orientation of a body part based on the relative direction of the gravitation field in X axes during 24 hours.
  - **Stepping behaviour**: measures the rate of change in velocity of a body part during 1 hour.

Figure 1. Gait scoring system used to evaluate lameness on sows



Project Longevity 2010											**Gait: visual observations**				
Date:		**Breeding:**			**Week:**						**Observer:**				
					Front			Side				Back			
								front legs		Rear legs					
No Sow	Score 0: normal 1: abnormal 2: less weight 3: avoid putting weight on a leg 4:non ambulatory	Avoid putting weight on one leg	head bob	arched-back	less weight on one leg	asym. stiff	asym. circular mvt	asym. strides	asym. foot placement on the ground	asym. strides	asym. foot placement on the ground	less weight on one leg	asym. stiff	asym. circular mvt	asym. swagger of caudal

Figure 2. Position of 15 reflective markers on the sow and kinematic corridor

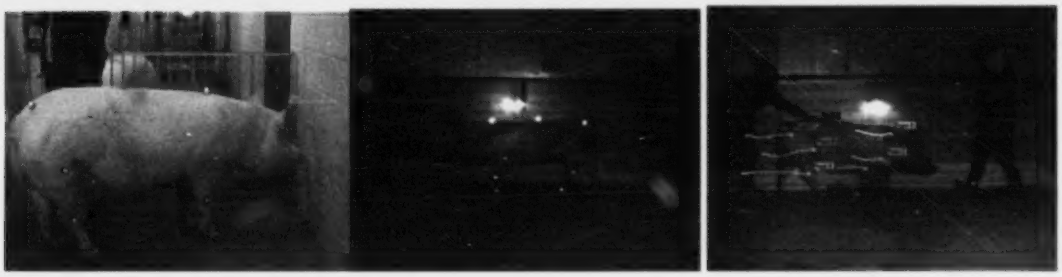
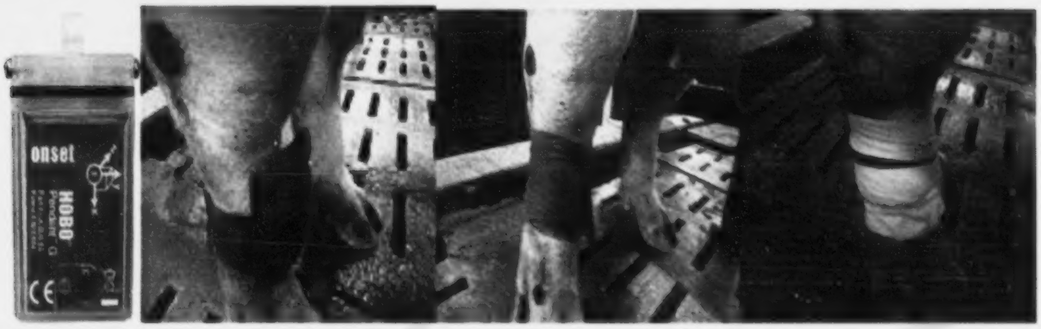


Figure 3. Fixing the accelerometer on the sow



Preliminary results

Kinematics

The stride length and walking speed was significantly shorter in lame sows compared to slightly lame or non-lame sows

Accelerometer (Hobo® data logger)

Standing posture: The proportions of time spent standing during 24 hours was significantly shorter in slightly lame and lame sows compared to non-lame sows.

Stepping behaviour: The number of steps per minute during feeding was significantly higher in lame sows compared to slightly lame and non-lame sows. The latency to lie down after feeding was shorter in lame sows compared to non-lame sows.

Conclusions

- Visual gait scoring is a subjective test to evaluate lameness and may not be sensitive enough to detect the effect of analgesia.
- There are automated quantitative methods that can be used in research to better evaluate lameness and pain mitigation in lame sows.

Acknowledgments

This work is in collaboration with Dr Nicolas Devillers (Sherbrooke, Quebec), Laurie Connor, University of Manitoba, Harold Gonyou, Prairie Swine Centre and others. This work is supported by Ontario Pork as well as Agriculture Canada through the Swine Research Cluster initiative. We wish to thank the assistance of the Arkell Swine Research Centre staff.

Will You Profit From Feeding Hogs to Heavier Weights?

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Packers want heavier carcasses to spread costs over more kilograms of pork processed. Heavier carcasses mean that hogs stay longer in barns to reach heavier, market live weights. Housing hogs in barns longer implies reduced barn turnover rates (reduced asset utilization) and more kg of feed per hog sold. Producers question whether there is economic benefit to them especially at times when pork prices dip down. In this paper, I highlight issues regarding marketing heavier weight hogs and provide some suggestions that producers can consider to focus on profitability.

Stocking Density

The most important consideration producers should make regarding housing hogs in barns longer is pen stocking density to 1st pull to slaughter. Not only hogs need to stay longer in barns to reach heavier market live weights, but also modern sows producer more pigs than ever compounding the crowding issue. The space individual hogs need ($0.034 \times BW^{0.67}$) and how many hogs to house per pens can be calculated. Typical pens measuring 2.5 x 6 m (8 x 20 ft) should house 17 hogs to a market weight of 120 kg (265 lb). If filled with 22 hogs, as it is common commercial stocking density, hogs will be crowded for the last third of their stay in such pens. Learn how to calculate pen space allocation and at what weight pigs reach it.

Effects of Crowding on Pig Performance

Crowding hogs reduces feed intake (ADFI) and consequently weight gain (ADG). Limited floor space AND restricted feeder access have additive effects. Gonyou et al. (2006) found that for every 3% below the critical individual pen space allocation, there was 1% degradation in daily weight gain and 0.75% degradation in feed intake. An additional feeder per pen could be provided for the last third of the growout period. However, modifying feed lines and installing/removing feeders make the likelihood of that happening practically nil. Feed conversion is not generally affected feeding corn-soybean meal diets to crowded hogs. That might not be the case feeding fibrous feedstuffs (DDGS). Growth performance suffers after hogs become crowded and remains so until hogs are removed at 1st pull to slaughter.

Pig Flow Bottlenecks and Barn Utilization

According to the pressure of forthcoming lots of pigs to fill a growout barn, housing hogs for extra days per turn to reach heavier live market weights can become an animal flow issue. Cleaning and disinfecting can be rushed, but can repairs be completed on time? Pigs can become so crowded before 1st pull to slaughter that it is hard to predict their weight gain. It could take 12 d for tail-end gilts to grow the 7 kg live weight required to reach a 5-kg heavier carcass. Is there a greater return on feeding ractopamine (PayLean™) to tail-enders? Cost per pig place amortized over 15 years may not make much of a difference per barn turn. But pig flow bottlenecks can become critical if stalled, crowded pigs reduce barn utilization and repairs.

Feed Cost vs. Revenue to Achieve a Heavier Carcass

According to finishing diet cost and progressively worse feed conversion at heavier live market weight, it could cost $4 - 8 more to feed a hog to gain 6.5 kg to result in a 5-kg heavier carcass. Packers now prefer barrows instead of gilts because backfat somewhat correlates with greater loin marbling. If crowding hogs results in a progressive feed restriction that reduces backfat, hogs may grade at a yield class discourage by packers. For a common AB packer grid, I calculated that a producer would not earn $5 if hogs lost 2mm of backfat kept longer in crowded conditions to yield a 5-kg heavier carcass. In other words, pen crowding can demote hogs in yield class. Not earning the $5 extra revenue also implies that the producer won't recover his feed cost of taking such hogs to a heavier carcass weight. *So... double whammy from crowding hogs kept to heavier weights!*

Topping Out Strategy

Hogs are marketed with little weight variation and are removed from pens at the target market weight. But the fastest growing hogs are not always removed until a truck load can be completed unless marketing from other barn at the same time. A proportion of these 1st-pull hogs therefore index poor because of exceeding the upper carcass weight within the grid core. The crowding pressure is relieved in pens where hogs are 1st-pulled, but not in all. This fact may explain why gilts are affected more by crowding than barrows. Wouldn't it be better to pull the X heaviest hogs from every pen to complete the 1st-pull truck load? Wouldn't ALL remaining hogs in the barn grow better instead of only those from pens where the fastest growing hogs were 1st-pulled? Crowding is most critical before the fastest growing hogs are pulled.

Reduce Breeding Herd, Sell Weaners or Build More Finishing Space?

To alleviate crowding a group of US scientists modelled 1) selling hogs as they reached market weight, 2) selling hogs within pen to maintain the required space allocation, even if that meant selling them light (1, 2 or 4 hogs to complete a truck load), 3) selling weaners, 4) reduce sow breedings, or 5) construct additional finishing space. The results differed somewhat according to packer grid (Tyson or Hormel). But they concluded based on return on equity (ROE) that reducing sow breeding was the least preferred (underutilized sow crates are the most costly asset), followed by selling weaners. Selling underweight hogs to maintain within-pen space allocation was intermediate. The best option was to construct additional finishing space as it would be amortized over the long term, followed by marketing hogs as they reached target market weight. This comprehensive study (Buhr et al, University of Minnesota) gives producers a good starting point to consider what to do to alleviate overcrowding long term.

Dressing Percentage

Producers can lose revenue not considering both the effect of diet on dressing percentage and not fasting hogs long enough before slaughter. Feeding barley instead of wheat or corn and worse yet high feed inclusions (>10%) of DDGS can reduce dressing by as much as 2%-points equivalent to ~$3/hog. Increasing live weigh to achieve the same carcass weight could cost $4 more on feed. The best is to reduce the fibre content of the finisher diet. One common strategy is to entirely withdraw DDGS from the finisher diet when producers start feeding PayLean™ close to market weight.

Feed Withdrawal

According to diet cost up to $3 worth of undigested feed can be found in the stomach and guts of pigs taken directly from their home pen with uninterrupted feed access to the truck destined to the abattoir. Hunger-related drinking can reduce dressing percentage. But not fasting hogs long enough (12 – 24h including lariage) can affect pork quality and the proportion of pork that meets export grade. So not fasting hogs, producers not only reduce their revenue, but also can impact the packer and Canada's pork exports. If one considers building additional finishing space, prioritize an in-barn lariage area near the loadout shut.

So… Will You Profit from Feeding Hogs to Heavier Weights?

Several strategies will lead producers towards profitability marketing heavier live weight hogs:

Short-term:

- ✓ Withdraw fibrous feedstuffs from the finisher diet
- ✓ Implement proper fasting/lariage on-farm before loading hogs to slaughter
- ✓ Top out 1st-pull of hogs a bit light within the grid core to provide more space sooner to remaining
- ✓ Adjust feeders as pigs are removed from pens to minimize feed wastage

Mid-term:

- ✓ Constantly compare scenarios: extra feed cost (Paylean™?) vs. extra revenue of heavier carcasses
- ✓ Consider marketing a portion of hogs on a light weight grid. Can you ship to a small local abattoir?

Long-tem:

- ✓ Consider building more on-site finishing space, but prioritize in-barn lariage space
- ✓ Focus on minimizing 'crowding days' to 1st pull to slaughter to maximize ADFI and ADG

Air Filtration for Swine Operations

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Background

In the early 2000's, air filtration was experimented on with several boar stud operations in the hog-belt of the American mid-west. In 2005, the first 6 operations successfully implemented such a system. Since that time, dozens (hundreds?) of operations have adapted to this new technology across North America. In the early years, this was mainly done for boar studs and pure-bred nucleus barns, but the past 3-4 years has also seen many multiplication and even commercial operations implement air filtration too.

Filters: Terminology & Ratings

MERV (Minimum Efficiency Reporting Value) is the industry-standard ratings system used to measure the effectiveness of air conditioner filters. The original standard for pig farms has been a MERV-16 rating (blocking a 0.3 μm particle); this is the same used for hospital surgery rooms. In the past 3 years, some American farms have started using a MERV-14 filter (with lower particle blocking capabilities), due to cost.

Other named filter rating terms of air filtration systems that are also used in the industry are: HEPA, L6 or L9, and HVAC.

2 Types Of Air-Filtration

Partial Filtration

Barns that have a partial filtration system use them 100% for most of the year (~9 months), but by-pass them by using a kick-down door during the summer months when aerosol disease transmission is considered lower. This system is usually set up with a very large bank of air filters situated before a cool cell, and allows for large or normal volumes of air to be drawn through a barn.

100% Filtration

As the name would suggest, this system is used 100% of the time for the entire year. A noteworthy feature of this system is that air flows are significantly lower than conventional ventilation; and as a result utilizes significantly less filters. Due to lower airflows, this type of system requires air conditioning too. Because the air comes in cool all year round, the ventilation needs are more similar to winter time.

Challenges

As the vast majority of swine barns are retrofitted with these air-filters (as opposed to being built with air-filtration in mind), there is a LOT of pre-planning & customization that will need to occur. Hiring good and experienced contractors who genuinely enjoy a challenge is key, as it is ideal to have this project done right the first time.

An important decision is regarding what kind of air pressure that you desire to use for your filtered barn: negative, neutral, or positive. Negative air pressure infers more air being exhausted than coming in. Neutral is balanced air flows of incoming & outgoing air. Positive pressure infers more air entering the barn than what is exhausted out. Whichever air pressure chosen for your barn can be implemented by using programmable computerized ventilation equipment; and air pressure can be monitored using specialized equipment (e.g. Magnehelic). Each option has its strengths and weaknesses.

Another challenge is internal air flows. After the barn has the original or existing ventilation heavily modified for air-filtration (which usually results in much lower air flow), it is important to deal with dead-air pockets throughout the barn. Installing recirculation fans is a simple and very effective way to mitigate areas of poor air quality, as fresher air is circulated through-out the barn.

When bringing in materials or removing dead stock, there needs to be an air-lock room attached to the barn so that these activities can take place. This air-lock room will regularly need to be disinfected with powerful fumigants; and as such is a safety concern for humans and animals alike.

Summary

Air filtration for swine operations has been around since 2005 and has been very effective at protecting swine operations from PRRS and other airborne diseases. The operations that have made the transition to air filtration have required customization and new procedures to make it work. Due to the success of air filtration, additional barns continue to implement this new technology.

Study of an Integrated Management System of Deoxynivalenol (DON) in Ontario Corn

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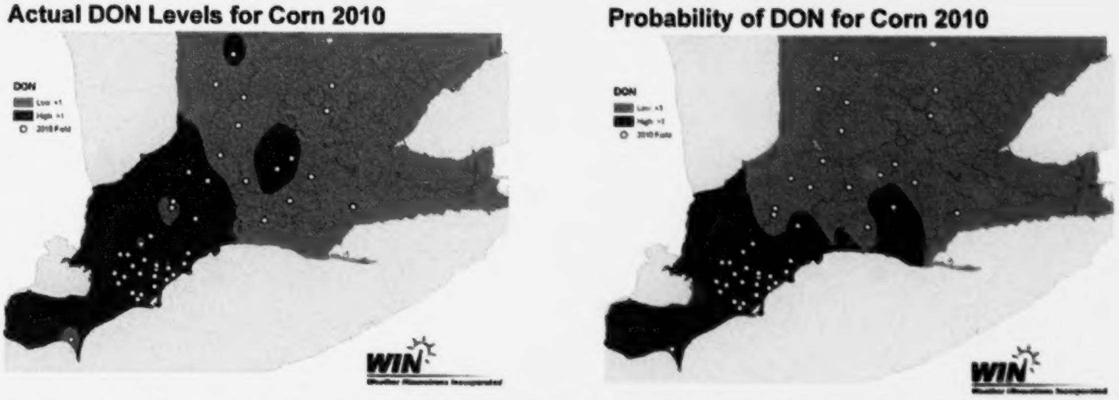
Gibberella ear rot caused *by Fusarium graminearum* is an economically important disease of corn. The fungus produces deoxynivalenol (DON), which is the most common mycotoxin found in Ontario. Swine are particularly vulnerable to DON exposure causing feed refusal, weight loss and immune-suppression at lower doses. *Gibberella* ear mould infestation and subsequent mycotoxin contamination are present in southwestern Ontario with different degrees of severity every year, potentially threatening our competitiveness in the export market. This report is a compilation of data and results on monitoring and study strategies for prevention, control and surveillance of DON in corn from 2009

Crop Surveillance

More than 700 corn samples were analysed for DON in 2010 and 2011. Relatively low levels of DON were found in 2010 with 76% of the samples recording less than 1 ppm with an average concentration of 0.8 ppm. In 2011, DON contamination exceeded 1 ppm in 72% of samples analysed so far with an average concentration of 3.5 ppm. Furthermore, 23% were contaminated with DON levels greater than 5 ppm. Analysis of the geographic distribution of the outbreak is still underway.

Weather based forecasting

Data obtained during the 2009 and 2010 cropping seasons were used to correlate weather information with various stages of the corn crop development to determine which stage is most susceptible and shows the highest correlation to the final production of DON (measured at harvest). For validation purposes, information on hybrid sensitivity to *F. graminearum* infection and/or mycotoxin accumulation obtained from our misting system was incorporated into the model. This information only includes Bt-hybrids encountered in 2009 and 2010 (a total of 384 data points). Preliminary results showed that high rainfall around the silking period and moderate temperature after silking are associated with DON accumulation in grain samples. The actual and predicted maps of DON from 2010 samples are compared in Fig 1. Improvement in a pre-harvest DON prediction model is expected with additional datasets collected during the 2011 cropping season.



Actual DON Levels for Corn 2010

Probability of DON for Corn 2010

Fig 1. Comparison between actual versus predicted DON values for corn across Ontario in 2010.

Hybrid selection

Our results confirm the feasibility to evaluate a large number of commercial hybrids through a controlled environmental screening program on campus. A total of 55 advanced and commercial hybrids and 3 susceptible check hybrids were evaluated in 2010 for their abilities to accumulate DON. Corn hybrids evaluated varied significantly for DON contamination in kernels ($p < 0.05$). These hybrids showed a large range in their response to DON accumulation from 1.5 to 12.8 ppm with a mean contamination level of 4.2 ppm. The variability to the response to toxin accumulation in different cropping seasons was evaluated in 30 hybrids planted in 2009 and 2010. Pearson's correlation coefficient was 0.734 (Fig. 2) indicating a strong linearity between the two sets of data showing high consistency in toxin levels between years and hybrids.

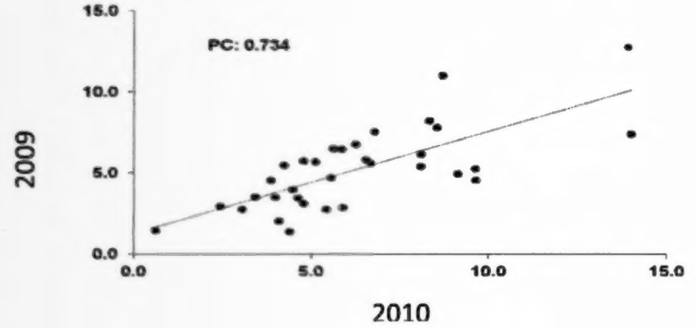


Fig. 2. Pearson correlation between DON accumulation in grains of 30 corn hybrids inoculated and maintained under an overhead mist irrigation system in 2009 and 2010.

Fungicide application

In 2009 and 2010, studies to understand the optimal application timing of prothioconazole (Proline) using two hybrids were conducted under misting irrigation trials. When compared with the untreated control, toxin reductions of 58%, 49% and 38% were observed when prothioconazole was sprayed at full tassel, full silking and 5 days after silking, respectively (Fig 3). No toxin reduction was observed at V16-17 and an increase in toxin levels was observed at 11 days after silking. In addition in 2010, the efficacy of the timing was evaluated in one field trial using a high clearance sprayer equipped with flat fan drop nozzles. Toxin reduction of 58%, 64% and 30% was observed when prothioconazole was sprayed at full tassel, full silking and 5 days after siliking, respectively. Similar results were obtained in our field trial. In 2009 and 2010, the effects of sprayer/nozzle configuration on efficacy for the control of DON contamination was also studied in 3 field trials using prothioconazole. Different spray pressure in the boom (5, 10, 20 GPA) and nozzle configuration (nozzle mounted above the crop, drop nozzle directed to the silk and combination of both) was studied. Mean DON contamination level in the untreated control was only 1.2 ppm. The same trials were repeated in 2011.

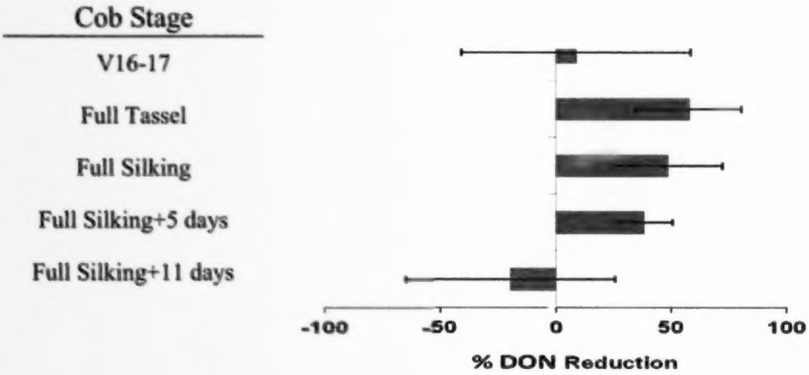


Fig 3. Percentage of DON reduction in harvested corn grain after treated with proline 200 g a.i/ha at different stages of cob development

Periweaning Failure-to-Thrive Syndrome – Awareness and Prevalence

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Introduction

Periweaning failure-to-thrive syndrome (PFTS) is a clinical condition seen in newly weaned pigs and has previously been referred to as post weaning catabolic syndrome (1). A PFTS affected pig will lose their appetite, lose weight, become weak, debilitated, and demonstrate oral behavioural changes, usually within 7 days of weaning. Presently, the cause of PFTS is unknown but some common features have been reported from farms that have described PFTS affected pigs:

- Pigs are typically clinically normal when weaned at ~21 days of age
- PFTS affected pigs are usually visually identified by 60-72 hours post weaning.
- Farms that have reported cases of PFTS use typical management practices for newly weaned pigs, i.e. offering creep feed, free-access to water at weaning.
- At this time, the most common reported clinical signs is a repetitive, oral, chomping motion with the affected pig resting its head on the back of a pen-mate.

Research Problem

The estimated incidence of PFTS is quite variable and can be as low as < 3% of pigs being affected to as high at 20% (1). Presently, an accurate estimate of the prevalence of the syndrome is unknown. The cause of the syndrome is also currently unknown and this is felt to be due to the inconsistent recognition and inaccurate recording of PFTS-mortality by producers and swine veterinarians (2). Characterization of the level of mortality related to PFTS is needed to access the prevalence and economic impact of the clinical syndrome.

Objectives

The objectives of this project are to improve industry awareness and recognition of the syndrome through video footage and commentary, and, to determine the crude prevalence of PFTS in North American swine herds.

Research Methods:

An instructional video was developed for the purpose of training veterinarians and farm workers on the characteristic clinical signs of PFTS. Swine veterinarians that are current members of the American Association of Swine Veterinarians were asked view the instructional video online. After watching the video they completed an online prevalence survey that was also available online from September 1 – December 31, 2011. Oral presentations were made in the fall of 2011 at many practitioner and producer meetings as part of an awareness campaign to increase the recognition and classification of the syndrome. Veterinarians could watch the video and also complete the survey at any of these meetings.

Results to Date

The online survey has just been completed. Analysis and results are pending.

Take Home Message

The definition of PFTS remains at the clinical level. Development of an increased awareness of the syndrome,as well as the typical clinical signs observed, is an important first step towards determining the clinical and economic significance of the disease.

Acknowledgements

Funding for this project has been provided by the Canadian Swine Health Board, Agri and Agri-Food Canada.

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Swine Innovation Porc
aka "The Cluster" or "Canadian Swine Research and Development Cluster"

Stewart Cressman, Ontario Pork

History

In December 2008, a draft of the "Growing Canadian Agri-Innovation program – Canadian Agri-Science Clusters Initiative" was released by the federal Government. The program was designed to help key industry-led agricultural organizations pull together national scientific and technical resources to establish clusters to support innovation for enhanced profitability and competitiveness. The goal was to reduce the time needed for new products, practices and processes to reach the market.

The Fédération des producteurs de porcs du Québec (FPPQ) hired a consultant to investigate the program and with the Canadian Pork Council (CPC) created a committee with representation from Ontario Pork, Manitoba Pork, Sask Pork, Alberta Pork and the National Pork Value Roundtable. Canadian researchers were contacted and brief proposal overviews were submitted. The committee received 60 submissions were received and consideration was given to 20 for full submission.

The final proposal detail and guide was release for the federal program in May 2009 and a request of $14M was made. CPC official incorporated the Canadian Swine Research and Development Cluster in January of 2010. It is now being branded as Swine Innovation Porc.
The grant application was successful in obtaining $9.5 million dollars for the research that was outlined in the application.

Swine Innovation Porc contracted program administration with the Centre du development du porc du Quebec (CDPQ). Technology Transfer Activities are being conducted jointly by the CDPQ and the Prairie Swine Centre (PSC).

Research

With the funded allocation Swine Innovation Porc has secured:

- 10 projects to increase Canadian pork industry competitiveness
- 4 projects to increase pork industry differentiation

A summary of the funded projects is attached.

These projects involve:

- 15 universities (8 in Canada)
- 9 research centres (8 in Canada)
- 5 provincial pork associations (involvement in 7 projects)
- 19 private industry partners (12 in Canada)

CPC, Swine Innovation Porc, as well as other clusters that were funded under the federal program have requested continuation of the program. Planning for a future program and work to establish national priorities have started.

Following is a listing of the funded research portfolio.

Swine Innovation Porc

Our Research and Development Activities

Project Title	***Objectives***
Food safety and microbial quality	
Use of tools related to molecular characterization, systemic analysis of stakeholders and geomatics for identification of principal vectors and contamination sources by bacteria and virus indicators at the farm and slaughterhouse level.	To identify vectors and microbial contamination sources among herds and slaughterhouse using geomatic, systemic and genomic tools.
Animal welfare	
Sow Housing: risk factors and assessment techniques for lameness, productivity and longevity in group and individually housed gestating sows.	Assessment of risk factors affecting the productivity and longevity in gestating group housed sows, and over a variety of management systems, with a special focus on lameness.
Study of the efficiency of water sprinkling in the truck after loading and prior to unloading at two different environmental temperatures on core body temperature and carcass and meat quality in pigs.	To provide the pork industry with a clear procedure to employ on the truck in warm conditions, with the aim of limiting animal losses during transportation and improving pork quality.
A comparison of three animal welfare assessment programs on Canadian swine farms.	Compare the three on-farm animal welfare programs as they pertain to Canadian farms.
Use of non-penetrating captive bolt for euthanasia of neonate, suckling and weaned piglets up to 9 kg.	Investigate the effectiveness of the modified design of the non-penetrating captive bolt for euthanasia of neonatal piglets as well as older piglets.
Environmental changes	
Development of an innovative air cleaning system for swine buildings.	To improve the acceptability of swine facilities in rural areas by reducing their potential environmental impacts.
Equipment standardization	
Development of an innovative precision farming system for swine.	Develop a commercial, fully automated precision feeder and acquire the required scientific knowledge to feed pigs individually with daily diets tailored for optimal management of both feeds and animals.

Development of standards for swine production systems.	To develop a methodology for analyzing the cost/benefit of system optimization and standardization that can be applied to commercial swine farms To ensure that concepts identified in this project can be translated to the farm, providing a competitive advantage to Canadian pork producers.
Feed inputs and feeding	
New and innovative swine feeding programs to enhance competitiveness and pork differentiation: The Canadian feed & pork value chain	To develop a unique Canadian feed management strategy and feed ingredient data base for optimum productivity that also considers nutrient excretion, reduced antibiotic use during the growth phase, and pork quality. This unique database combines digestibility and bioavailability trials and novel feedstuff analyses.
Novel nutritional strategies for optimum sow and piglet productivity.	To develop unique Canadian feeding management strategies for optimum sow and piglet productivity, taking into consideration production efficiencies, including pig performance up to market weight, food safety, pig welfare and use of antibiotics.
Mycotoxins	
Efficacy of feed additives in mitigating the negative impacts of mycotoxin contaminated feed on performance and health of piglets.	Develop a protocol to evaluate the efficacy of feed additives available in Canada to attenuate the toxicity of naturally contaminated grains that may contain more than one mycotoxin and to mitigate the negative impact of mycotoxins on pig performances.
Mycotoxins contents evaluations of corn hybrids adapted to Quebec growing conditions.	To determine, under natural disease pressure, whether there are any differences between hybrids (Genotype effect, G) in their grain content levels for four different mycotoxin (Deoxynivalenol, fumonisin, zearalenone and T-2 toxin) in 3 different environments (Environment effect, E). G x E interactions will also be evaluated.
Genomics	
Capturing genetic merit in differentiated pork production systems through genomics.	Demonstrate that alignment of the excellent genetic potential of Canadian dam-line sows and AI stud boars, with management strategies that recognize the origins of major variation in phenotypic traits of terminal line litters, provides major competitive advantages to Canadian pork producers.
Development of new genomic tools to improve meat quality traits and production efficiency in pigs.	Develop new genomic tools to improve meat quality traits as well as enhance product differentiation and efficiency of pork production.

Canadian Swine Health Board (CSHB)

The CSHB was formed in 2008 with a mandate to provide leadership, coordination and support in the management of the health of the Canadian swine herd. Through an inclusive approach involving all stakeholders, the CSHB is working to develop and implement a long term strategy for control of diseases in the hog industry.

The CSHB chose three key areas on which to focus:

- Biosecurity and best management practices
- Research on porcine circovirus and associated diseases (PCVAD) and other emerging diseases
- Long term disease risk management strategies including surveillance

Biosecurity and best management practices initiatives are covered under a separate note.

Research projects have been initiated looking into aspect of PCVAD, Gilt Acclimation, Swine Dysentery (which is appearing in Western Canada), Porcine Reproductive and Respiratory Syndrome (PRRS) and Periweaning Failure to Thrive Syndrome (PFTS). Research and development of new diagnostic tools are also being funded.

The CSHB is providing three years of funding support to six different swine health research organizations across Canada. Each site will appoint a Post Doctoral Fellow. Post Doctoral Fellows are typically young scientists who have completed their PhD programs and are available to join established research teams to work on specific projects and programs. Their goals are to complete research tasks, gain experience and publish scientific papers.

The locations and general research areas are:

- University of Alberta - Genomics and disease resistance using Swine Influenza as a model
- University of Saskatchewan - Joining emerging disease research team
- Vaccine and Infectious Disease Organization - Vaccine technology development using immune stimulators with Porcine Circovirus Type 2 (PCV2), PRRS and Swine Influenza Virus (SIV)
- University of Guelph - Infectious disease spread modeling based on PCV2 and PRRS
- University of Montreal - Supporting work in Le Groupe de recherche sur les maladies infectieuses du porc (GREMIP) Team
- University of Prince Edward Island - PRRS disease spread, traceability and modeling

This initiative will significantly increase the science capacity in Canada as well as jump start a new generation of young scientists.

The **Long Term Risk Management** Area had completed a gap analysis and funded work toward development of a long term risk management strategy. There are projects assessing surveillance and detection of PCVAD and PRRS. There are plans to pilot a humane destruction center for Canada. A number of ventilation projects are also being initiated to aid in reducing air borne disease spread.

Funding for the CSHB terminates on March 31, 2013. There are efforts being made by the CSHB and CPC to obtain a stable and ongoing source of funding and support in order to address economic and "One Health" related swine health problems and issues in the future.

University of Guelph Pork Research

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The University of Guelph has the largest and most productive pork research program in Canada. The research program includes both applied work with projects involving producers, practicing veterinarians and other members of the swine industry, as well as projects that are very basic in nature with no immediate application. The strength of the Guelph program is the collaborative efforts of faculty from the Animal and Poultry Science Department of the Ontario Agricultural College and faculty of the Ontario Veterinary College. Besides this base there are contributions from other researchers from a variety of disciplines including food science, economics, environmental science and engineering. The research program also receives input from faculty at Ridgetown College. In the immediate Guelph area there are various opportunities for research collaboration including the Animal Health Lab, OMAFRA, Agriculture and Agri- Foods Canada, and the Public Health Agency of Canada. It is difficult to summarize all of the various swine related research that is taking place at the moment at Guelph but the following is a list of some of the faculty who are engaged in swine work:

Kees deLange (nutrition and growth modeling), Cate Dewey (health management and epidemiology), Ming Fan (nutrition), James France (nutrition-modeling), Bob Friendship (health management, welfare, food safety), Tony Hayes (molecular aspects of immunity and disease), Ron Johnson (pharmacology), Julang Li (molecular biolology), Brandon Lillie (molecular aspects of immunity and disease), Janet MacInnes (bacteriology), Ken McEwan (economics), Scott McEwen (public health and food safety), Zvonimir Poljak (health and epidemiology), Peter Purslow (food science), Andy Robinson (genetics), Jim Squires (boar taint), Trevor Smith (mycotoxins), Keith Warriner (food safety), Alfons Weersink (economics), Scott Weese (public health), Tina Widowski (behavior and welfare), Bruce Wilkie (immunology).

In addition to this critical mass of dedicated researchers in a wide range of disciplines there are a large number of graduate students, post-doctoral fellows, research associates and technicians and a strong infra structure of research facilities. There is a 300-sow research herd at Arkell and pig housing for research work at Ponsonby, in addition to various on-campus facilities including a level 2 isolation unit and an abattoir. Very recently the research program received a boost with the completion of new pathobiology and diagnostic laboratory facilities. This will greatly enhance disease surveillance work at Guelph.

More information regarding the pork research program can be obtained by visiting the University of Guelph website or contacting the individual researchers directly.

Ontario Pork Research and Development

Jean Howden, Ontario Pork

Ontario Pork has been evaluating research funding and research priorities that will foster a healthy business environment for industry development and innovation. We are currently conducting an online survey to assess research requirements for our producers. Currently the priorities focus on Ontario Pork's Strategic Plan and center on production and industry development in the following areas:

Production

- Focus on production issues including: Animal Health, Nutrition, Reproduction,
- Environmental Conditions, Animal Welfare, and Food Safety
- Products that promote health benefits of pork
- Improving long term economic and environmental sustainability

Product/Marketing Development

- Focus of development of new markets and/or new pork products
- Products that promote health benefits of pork

Economic and Business Sustainability

- Focus on applied economics relative to the entire swine production chain
- Competitiveness of the Ontario Swine Sector
- Trade Issues and Farm Policy
- Production efficiency
- Products that promote health benefits of pork

Social

- Focus on both Quantitative and Qualitative methods for understanding industry trends and consumer perception.

In 2011 we held two calls for research proposals and offered funding of $1.1 million to 19 different researchers or project managers for 22 projects. Other contributions to this portfolio of research have provided an additional $2.16 million and significant in-kind.

Following is a brief synopsis of the funded research projects in the Ontario Pork Research portfolio.

Funded Projects

Project No. 11/002 **Researcher** Tim Blackwell

Title On Farm PRRS filter testing

Synopsis This air filtration study is unique because the filters will be used to filter the air leaving the barn through the exhaust fans rather than filtering exhaust fans rather than filtering the air entering the barn. Several models have demonstrated that filtering exhaust air from PRRS positive farms is more cost effective than filtering the incoming air on all the PRRS negative barns in the vicinity of the PRRS-positive barn.

Project No. 11/003 **Researcher** Phil McEwen

Title The effects of feeding novel co-products from the distillation industry on pig growth performance, carcass traits, and pork quality.

Synopsis The project will evaluate the effects of feeding new novel feedstuffs, produced from the distillation industry, on pig gowth performance, carcass and meat quality, and economic returns.

Project No. 11/005 **Researcher** C.F.M. de lange

Title Nitrogen requirements and utilization in growing pigs

Synopsis The research will quantify the efficiency of using nitrogen from different sources (protein or non-protein nitrogen infused into the hindgut; non-essential amino acids) for whole body protein deposition in pigs fed diets that are limiting in either an essential amino acid (valine) or non-essential amino acids (nitrogen). In addition, we will examine the impact of feeding diets that supply varying amounts of non-essential amino acids and similar amounts of essential amino acids on growth performance, feed efficiency, carcass quality and nutrient utilization efficiency in growing-finishing pigs.

Project No. 11/010 **Co-ordinator** Lori Moser

Title PRRS Area Regional Control and Elimination

Synopsis The goal is to implement a regional PRRS control and elimination in Ontario

Project No. 11/230 **Researcher** Ron Johnson

Title Canadian global food animal residue avoidance databank (gFARAD)

Synopsis Financial support for the Ontario Veterinary College, Guelph, Ontario, location of the Canadian gFARAD for additional requirements to provide veterinarian information on residue avoidance.

Project No. 11/012 **Researcher** Ann Huber

Title Pathogen die-off rates following manure application under Ontario field conditions

Synopsis This project employs a sentinel chamber methodology to determine the decline rates manure-derived pathogens (e.g. Salmonella, Listeria, E coli 0157) under contrasting manure application management (spring, late summer, fall; incorporated or surface applied) for Ontario field conditions.

Project No. 11/001 **Co-ordinator** Anita Ivanauskas

Title Premium Pork Positioning

Synopsis A consumer assessment of pork and understanding of pork marbling

Project No. 11/013 **Co-ordinator** Crystal Mackay

Title 2011 Farm issues Public Attitude Research

Synopsis The research findings create a greater understanding of consumer attitudes and the challenges faced by industry stakeholders to build consumer confidence in today's food and farming. The findings of the 2011 research will assist the pork industry's public relations, marketing and communications initiatives in measuring effectiveness and prioritizing messaging on all efforts. It will also provide guidance to the pork industry on how specifically to build trust with opinion leading consumers who drive social change and set policies which have implications throughout the supply chain. More general economic implications are outlined in the full proposal.

Project No. 11/015 **Researcher** Peter Purslow

Title Using proteins and protein fragments from meat to enhance human iron uptake from dietary supplements

Synopsis This project will lead to the development of meat-based functional protein additives (nutraceuticals) for enhanced iron uptake, so benefiting the health of Canadians. The research aims to develop much more efficient iron supplements, which will provide new opportunities for product development of functional foods and nutraceuticals with added value.

Project No. 11/219 **Researcher** Ron Johnson

Title Rodenticide Ingestion in Swine: A Project to Assist Veterinarians with Detection and Establishing Withdrawal Times

Synopsis Bromadiolone will be administered at high (1.0 mg/kg; 20 hogs) and low (0.1 mg/kg; 20 hogs) doses to hogs. Animals in each group will be sacrificed at either 3, 7, 14, 21 or 28 days post dosing. Samples will be taken pre-dosing and post dosing (sacrifice) for assay of bromadiolone levels.

Project No. 11/210 **Co-ordinator** Lori Moser

Title Development and Field Trial of Producer Driven PRRS Area Regional Control and Elimination Projects (PRRS ARC& E).

Synopsis This project will develop tools required to carry out producer initiated PRRS ARC&E projects including an application form and criteria for approval of requests for funds, modeling a concept for delivery of advanced biosecurity and disease control which is driven by motivated producers. It will provide funds to initiate small scale PRRS control and elimination projects throughout Ontario when producers in concert with their veterinarians and service providers have interest in working together. Projects are expected to include 2 to 20 farms each. Tools developed in other projects will be utilized to facilitate delivery. The project will also include coordination and communications associated with the regional projects to maximize lessons learned between areas.

Project No. 11/221 **Researcher** Ken McEwan

Title An Evaluation of Alternative Hog Pricing Mechanisms For The Ontario Industry

Synopsis The pricing model currently in use in Ontario is based off a USDA hog price report and adjusted for local conditions. While it seems that this has worked fairly well it may not be representative of Canadian supply and demand conditions, it could be geographically biased. The model may not reflect true US prices and packer bias could be a concern. Ontario producers need to know if the current model is the most accurate method to price hogs or if another model such as carcass cut-out values, COP or profit sharing would be a better fit.

Project No. 11/229 **Researcher** Mihaela Ciuciureanu

Title Product Development with Sow Meat

Synopsis This project will provide samples of sow meat to further processors, as an introduction to the product Arnold meat packers can provide. The target is processors of dry cure salami and sausage.

Project No. 11/227 **Researcher** Paisley Canning

Title Improving the efficacy of porcine circovirus type 2 (PCRV2) vaccination: Effects of maternally-derived antibodies and neonatal viremia on PCV2 vaccination response

Synopsis This study will sample 110 piglets per farm on two commercial farms using two

common PCV2 vaccines. Piglets will be weighed and blood sampled at birth, prior to and after PCV2 vaccination and at weaning. Sera will be tested for non-specific maternal antibodies, PCV2 viremia, and for PCV2 specific antibody titers. The purpose of this study is to test for relationships between pig weight, non-specific maternal antibodies, PCV2 viremia, and PCV2 specific antibodies generated after vaccination. Both farms will be considered independently and factors affecting PCV2 vaccination response will be analyzed within farm.

Project No. 11/225 **Researcher** Mark Mitchell

Title A Study of Quantitative, Multi-class, Multi-residue Drug Analysis LC-MS/MS and the Qualitative, Charm Kidney Inhibition Swab (KIS) Test Supporting Detection and Identification of Antimicrobial Drugs

Synopsis This project will utilize kidney and muscle tissue samples collected from 50 condemned swine carcasses. The tissues will be analysis using both the Charm KIS™ test and the multi-residue drug detection by LC-MS/MS methods.

Project No. 11/213 **Researcher** Paul Luimes

Title Nutritional strategies for feeding sows

Synopsis Sows will be divided into and fed according to 6 treatments (2 dry sow & 3 nursing sow). Sow (feed intake, back-fat changes, reproductive performance, etc) and piglet (gain and survival) data will be recorded to determine which system(s) are most efficient for producers to use

Project No. 11/228 **Researcher** Heather Wilson

Title Development of an oral vaccine for piglets against Lawsonia intracellularis: A platform technology

Synopsis This basic research looks at a different platform in which to design and administer vaccines to neonates. The newborn piglet gut is semi-permeable to facilitate absorption of maternal antibodies. If neonates are orally vaccinated with hours after birth, they can develop mucosal (gut) immunity which can protect them against infection, thus preventing gut wall lesions and improving production. Antigens from L.intracellularis will be use as a model in this research.

Project No. 11/214 **Researcher** Ron Ball
Title Validation of revised sow feeding regimen
Synopsis Protein and energy requirements determined simultaneously in early and late gestation. Statistical evaluation of all gestation requirement and performance data in model for individual sow requirements. Testing of revised feeding regimen on farm to assess impact on performance and economics compared to current feeding

Project No. 11/220 **Researcher** Ken McEwan
Title Benchmarking the Ontario Swine Industry - 2011
Synopsis This project aims to benchmark and describe Ontario's pork industry in terms of producer demographics, farm type, resources used and future plans. This will be done by surveying every producer in Ontario that owns one or more pigs.

Project No. 11/212 **Researcher** C.F.M. de lange
Title Determinants of amino acid requirements of gestating and lactating sows
Synopsis Studies are proposed to establish the pattern of whole body N retention at 2 levels of energy intake during gestation, based on 5 sequential and conventional N balances observations. These observations are made on 36 sows and during 3 subsequent gestation periods. In addition, studies are proposed to evaluate the impact of feeding diets that supply varying amounts of total protein and similar amounts of the critical essential amino acids on lactation performance of 24 sows. In this manner key determinants of amino acid requirements of gestating and lactating sows are quantified. The generated information will complement empirical amino acid requirement studies and address the void if information required for a factorial estimation of amino acid requirements of sows across parity and at varying levels of sow productivity.

Project No. 11/217 **Researcher** Robert Friendship
Title Pain control for castration and tail docking
Synopsis Piglets will be divided into treatment and control groups. The different treatment groups will consist of pigs receiving a local anesthetic 10 minutes before castration, piglets receiving an analgesic 30 minutes before castration, a group receiving both a local anesthetic and an analgesic prior to tail docking and castration, controls will receive placebo injections. Pain will be assessed by monitoring behaviour, vocalization and cortisol levels, as well as growth performance.

Project No. 11/208 **Researcher** Michael Dyck
Title Identification selection and improved utilization of superior boars for pork production.
Synopsis Unlike other livestock industries, pork production has not fully realized the genetic gains and strategic advantages that AI can provide. This is due to: 1) ineffective evaluation of individual boar fertility, and 2) the excessive number of sperm used per litter born. Improving on these inefficiencies in AI would represent a major advantage to Ontario pork producers in a global food-animal marketplace. A reduction in sperm numbers per AI dose will enhance the use of genetically superior boars. Although 3 billion sperm/AI dose is an industry norm, recent research demonstrate that ~15-20% of boars currently in use demonstrate sub-optimal fertility, despite producing semen of "acceptable" quality. The fertility of these boars is further compromised when their semen is inseminated at less than 3 billion sperm/AI dose. This research will deliver novel tools and techniques that will improve breeding management practices in the Ontario pork production industry and ensure the link between the high genetic value of elite sires and terminal line progeny which are the foundation of an economically sustainable pork industry.

CQA®-ACA Update

Tim Metzger, Ontario Pork

The Canadian Quality Assurance (CQA®) program is a HACCP-based on farm food safety program for hog producers which was launched for hog producers in 1998. Today approximately 85% of hogs produced in Ontario are done so under CQA® registration. The Animal Care Assessment (ACA) program was launched in 2005 as an independent, voluntary tool for producers to demonstrate responsible pork production.

Since its inception, the ACA was always destined to become part of the overall CQA® program. While the CQA® program was designed to address food safety protocols, the ACA focuses on animal care practices which include:

- Stockmanship
    - Identification and care of sick or injured pigs
    - Space allowances
    - Mortality levels
    - Body scores – breeding stock
    - Humane euthanasia protocols

- Care of animals
    - Employee training

- Housing and environment
    - Temperature and Ventilation
    - Barn maintenance
    - Procedure in the event of power failures
    - Flooring
    - Feed and Water

The program was developed by a team of experts including pork producers, pork producer organization representatives, animal care researchers and government officials. Shortly after the introduction of the program, the pork industry experienced a severe financial setback, resulting in very limited participation in the ACA program.

In January 2011, the Canadian Pork Council passed a motion in to make the ACA become a required part of the CQA® program. Effective January 1st, 2012, all producers renewing their CQA® validation are required to meet the ACA program requirements. Beginning with 2012 CQA® renewals, producers due for a "Full CQA® Validation" will also need to have a "Full ACA Validation" completed by their validator. Those due for a "Partial CQA® Validation" can complete the ACA Self Declaration Report, and submit it to their validator along with their CQA® materials.

For more information on the harmonization of the CQA® and ACA programs please contact:

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National Biosecurity Training Program

Mike DeGroot, Ontario Pork Biosecurity Coordinator

In October 2010, the Canadian Swine Health Board (CSHB) released the National Swine Farm-Level Biosecurity Standard. To facilitate implementation of the standard, the CSHB developed a National Biosecurity Training Program for producers. The goals of this training program are to educate producers on biosecurity best management practices and to improve biosecurity measures, adapted for each specific site, based on the National Swine Farm-Level Biosecurity Standard.

Ontario Pork is facilitating the implementation of the program in Ontario. Funding is provided to producers to attend a training session ($150/barn site), complete a self-assessment form on their current biosecurity practices ($500/site), and have a farm visit from their veterinarian to discuss areas of biosecurity improvement specific to their site ($500/site). Training sessions for producers began in August and are ongoing.
As of Dec. 31st, 835 producers have attended a training session, representing 868 barn sites. Self-assessments and veterinarian farm visits have been completed for 346 sites.

As part of the training program, producers must consult with their veterinarian to determine two areas of biosecurity improvement for each barn site. A summary of the proposed improvements are summarized into categories in the chart below (Figure 1).

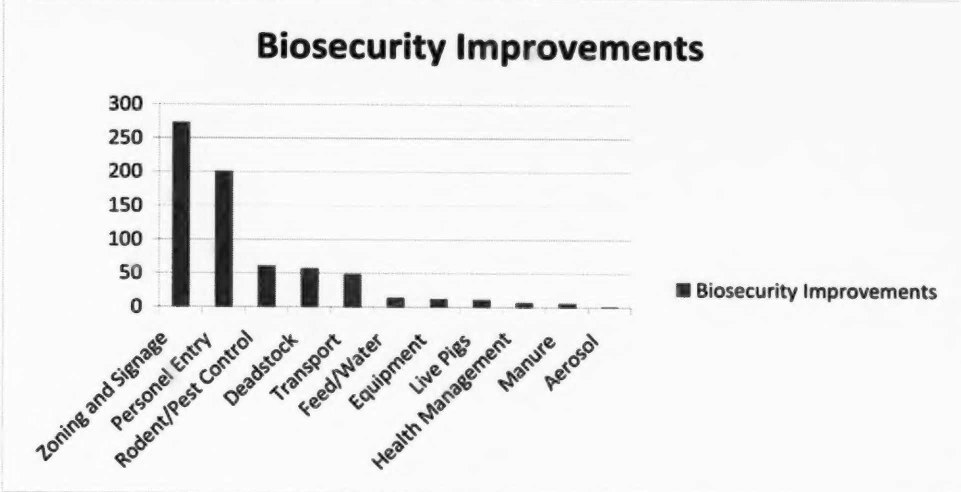

Figure 1. Number of biosecurity improvements listed for each biosecurity category for farms enrolled in the National Biosecurity Program. In total, 692 action plans of improvement were listed across 346 barn sites.

In total, 692 action plans of improvement have been generated on 346 sites. The most common areas of focus for improvement are in the categories of farm zoning and signage and personnel entry. For farm zoning and signage, Ontario producers have indicated a need to improve the signage on their farms, to clearly identify zones of controlled access and restricted access. Placing locks on barn doors is another common improvement in this category, to restrict barn access to authorized personnel only. Farm biosecurity signs will be provided to each barn site registered in the National Biosecurity Training Program. For the category of personnel entry, a lot of focus has been placed on implementing or improving a Danish Entry System, including providing written protocols for staff and visitor entry. Other categories that have been commonly identified as areas of biosecurity improvements include: deadstock handling, improve transport protocols, and better rodent/pest control. As the proposed improvements are put in place, the Ontario industry should benefit from these improvements to reduce the risk of disease spread within and between farms.

For more information, contact: Mike DeGroot, Ontario Pork Biosecurity Coordinator, mike.degroot@ontariopork.on.ca

Ventilation For Livestock and Poultry Facilities Manual Update

Robert Chambers
Ontario Ministry of Agriculture, Food and Rural Affairs

The manual "Ventilation For Livestock and Poultry Facilities" OMAFRA *publication 833 was* published in 2010. It consists of 270 pages and is available at a cost of $50 from Service Ontario and OMAFRA offices.

To date there have been 300 copies distributed. It is also the recipient of the **2010 Gold Award for Writing** from the **Association for Communication Excellence in Agriculture, Natural Resources and Life and Human Sciences (ACE)**. This includes all the land-grant universities in the USA. It also won the **2010 Silver Award for Photography** from **ACE.**

Ron MacDonald, P. Eng., Agviro Inc. and Harry Huffman P. Eng. provided the technical content, while Kerry Little, Corporate Photography provided many of the photos. The editing was done by Arlene Robertson, Robert Chambers, Harold House and Daniel Ward of OMAFRA.

The manual was prepared to assist producers and ventilation designers in the design, installation and maintenance of ventilations systems. The manual explains the basic design principles, operational requirements and maintenance of ventilation equipment in livestock and poultry barns in Ontario. The manual was written in plain language to clearly explain the ventilation and heating options available along with their pros and cons and the principles behind the calculations. Examples are provided throughout the book.

Topics covered in the manual include Ventilation Principles, Barn Insulation, Fresh Air Inlets, Fan Systems, Ventilation Controls, Heating Systems, Cooling Systems, Attic Ventilation, Natural Ventilation, Energy Conservation, Commissioning/Calibration and Maintenance/Troubleshooting.

Acknowledgments:

I would like to thank Arlene Robertson, OMAFRA, for providing the statistics.

Ontario Swine Health Advisory Board PRRS Area Region Control and Elimination Projects Update

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The Niagara PRRS Area Regional Control & Elimination (ARC&E) Project

The PRRS area regional control and elimination project (PRRS ARC & E) was initiated in February of 2010. The Ontario Swine Health Advisory Board (OSHAB) is working with industry partners to provide leadership for this project. The PRRS ARC&E project is a voluntary program in all aspects including participation and implementation of control and/or elimination strategies. The project has been extended to encompass a three year time frame. Funding has been provided by OMAFRA, OSHAB and industry partners, the Animal Health Strategic Initiative (AHSI) and the Ontario Pork research fund.

Project Objectives include:

- Implement an Ontario PRRS ARC&E pilot project in the Niagara region delivered as a voluntary program.
- Develop a culture of openness, transparency, cooperation & collaboration
- Lead a change in attitude - from independent to interdependent
- Target greater than 90% producer participation
- Heighten understanding & awareness of the importance of coordinated regional approaches that must be taken to combat PRRS & other emerging swine diseases, rather than relying on isolated efforts on individual farms.
- Improve communication & share knowledge related to biosecurity & disease control within the Niagara region and within the Ontario industry.
- Maintain competitiveness with trading partners and avoid any possible future disease related trading barriers.
- Reduce the prevalence of the PRRS virus (PRRSV) in the Niagara area.

The Niagara Peninsula area was selected as the project region as the first Ontario PRRS ARC&E zone based on the following criteria:

- Moderate pig density
- Motivated producers and service providers with identified champion(s) in the area
- Physical borders (lakes, highways, stand of trees etc) and/or reduced density on perimeters
- Pig flow considerations and limited pig transportation through the control zone
- Consideration of herd size and dynamics

A total of 76 sites have been identified in the project area. Producer participation is 97% (74/76 sites). A signed producer participation agreement is required prior to the diagnostic sampling. The participation agreement addresses issues of sampling, diagnostic testing, data sharing and confidentiality. Sampling and diagnostic protocols have been developed and all participating sites have been tested. Maps denoting PRRS status have been shared with the producers through area meetings and can be accessed by area participants using a password protected area of the OPIC website. The project funding per site includes the sampling and diagnostic costs, the PRRS risk assessment and the design of the on-farm biosecurity, control and elimination strategies. Two production systems have undertaken elimination programs and are currently conducting diagnostic testing to confirm the success of the project. Smaller neighbourhood cluster meetings to facilitate discussions on next steps in reducing area risks are planned for early 2012.

Mini-ARC&Es Project

This project will develop tools required to initiate smaller scale, producer driven PRRS ARC&E projects and will pilot a concept for delivery of advanced biosecurity and disease control which is driven by motivated producers. It will provide tools, coordination and funds to initiate small scale PRRS control and elimination projects throughout Ontario when producers, in concert with their veterinarians and industry partners have interest in working together. This concept is different from the traditional PRRS ARC&E format currently being executed in the Niagara Peninsula in that it offers the benefit of giving self-motivated producers who are committed to continuous improvement an opportunity to differentiate their business and foster leadership with regards to biosecurity practices which advance disease control and elimination in various areas throughout Ontario. It is believed that this approach will lead to greater sustainability by fostering leadership in the participants - a significant issue in the execution of PRRS ARC&E programs. This grassroots approach will facilitate farm level improvements in biosecurity practices that have the potential to spread to service providers and expand out into larger areas, resulting in wider exposure to disease control and elimination concepts and enhancing uptake of practices outlined in the national biosecurity standards. Criteria for acceptance and an application process is under development and OSHAB will have 2 to 3 calls for applications over the scope of the project.

Funding for this project has been provided through industry support and by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program. In Ontario, this program is delivered by the Agricultural Adaptation Council.

Reducing the Risk of Fire on Your Farm Booklet Update

Robert Chambers
Ontario Ministry of Agriculture, Food and Rural Affairs

The booklet "Reducing the Risk of Fire on Your Farm", OMAFRA publication # 837 was published in early 2011. To date over 8000 copies have been distributed free to producers primarily through insurance companies, fire departments and the Office of the Ontario Fire Marshall. Copies are also available free from OMAFRA or Service Ontario.

The manual was a result of the work of the Technical Advisory Committee on Farm Fires (TACFF) formed to address the fire safety risks. The purpose of the committee was to reduce the potential for life and property loss by identifying the regulatory and best management practices in the industry. The committee members were from Government agencies, Building Officials, Ontario Association of Fire Chiefs, The Insurance Industry, Farm Builders including Contractors and Engineers, Ontario Pork and the Electrical Safety Authority.

The manual is divided into 5 chapters under the headings

- Leading Causes of Farm Building Fires
- Preventative Maintenance to Reduce the Risk of Fire
- Preventing Fire Spread
- Reducing the Impact of Fire
- Assessing Your Risk

The management of fire risk is divided into two main themes, 1, what producers can do on a day to day basis to reduce risk and 2, what design features can be added at time of new construction or renovation to lower risk. There is also a one page self assessment to aid producers in determining the risk for their operation.

The ultimate goal of the manual is to reduce both the frequency of Farm Building fires along with their severity with proper maintenance and design over time. This will reduce the fire safety risk to farm workers, emergency responders and animals and the reverse the trend of increasing financial losses.

Acknowledgments:

I would like to thank Arlene Robertson, OMAFRA, for providing the statistics.

Study of Immune Responses Generated by Live *Salmonella* Vaccines in Weaned Pigs

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Background

Salmonellosis is one of the most frequently reported human enteric illnesses in Canada. *Salmonella* has been recovered from close-to-market pigs on nearly two-thirds of Ontario farms (Farzan et al, 2008). *Salmonella* Typhimurium is the most common serovar and is of concern because it is often resistant to multiple antibiotics, is commonly reported from human cases of salmonellosis, and is also a cause of clinical disease in pigs. Intervention strategies to control *Salmonella* at the farm-level have not typically been successful. *Salmonella* vaccination by means of live-attenuated strains administered orally has been suggested as the most effective approach (Haesebrouck et al, 2004) as oral immunization can stimulate local gut immunity (Letellier et al, 2001) inducing mucosal IgA secretion in the gut (Mittrucker et al, 2000). The oral *Salmonella* live vaccines can also induce cell-mediated immunity that may play a major role to protect pigs because *Salmonella* are facultative intracellular pathogens and may avoid humoral immune response in the intracellular environment (Lindberg and Robertson, 1983). In addition, the oral vaccine can be easily administered via the water and this approach is readily acceptable from a labour standpoint. *Salmonella* Choleraesuis oral vaccines are commercially available for use in pigs but there are no *Salmonella* Typhimurium oral vaccines registered for use in pigs in Canada. Recently an oral *Salmonella* Typhimurium vaccine has become available for poultry in Canada. The vaccine has been able to reduce *Salmonella* Typhimurium colonization of the internal organs of chickens. Yet, the immune responses induced by these vaccines in pigs have not been studied.

The objective of this study was to investigate the immune response in pigs generated by *Salmonella* Choleraesuis and *Salmonella* Typhimurium vaccines.

Materials and methods

A series of clinical trials were conducted on weaned pigs. The pigs were randomly assigned to three groups, two vaccinated and one control group. In each vaccinated group, pigs orally received either a live *Salmonella* Choleraesuis (SC) or *Salmonella* Typhimurium (ST) vaccine. No vaccine was delivered to the control group. Fecal samples and blood were collected at day 0 (prior to vaccination), 1, 2, 4, 7, 14, 17, 21, and 28. At the end of one trial (day 42) pigs in each group were euthanized, and necropsied. Tissue samples from ileocecum, liver, and spleen were taken. Fecal samples were cultured for *Salmonella*, and the presence of *Salmonella* in the tissues was examined by immunohistochemical staining. The presence of cytokines and antibody against *Salmonella* in sera was determined by ELISA. A mixed linear regression analyzing method was used to compare the level of serum IL-8 and TNF-α among pigs in three groups.

Results

Salmonella vaccine strains were not isolated from vaccinated animals during the trials. No positive section was observed in the ileocecal and the gland tissues from vaccinated pigs indicating that the vaccine strains did not colonize the entry site, i.e. ileocecal lymph nodes. However, IHC staining could demonstrate small clusters of a few bacteria in the tissue from spleen of two pigs in the *Salmonella*

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Choleraesuis (SC) group and two pigs in the *Salmonella* Typhimurium (ST) group that might had been exposed to non-vaccine strains previously. No antibody response against whole *Salmonella* could be detected. The host response measured as IL-8 seemed to be elevated in both SC and ST vaccinated animals versus control pigs one day after vaccination but a greater response was seen in pigs vaccinated by SC than ST vaccine ($P < 0.05$). The amount of TNF-α increased more in pigs vaccinated with ST vaccine compared to SC group. In general, vaccinated pigs had a stronger IL-8 response than TNF- α response ($P < 0.05$).

Conclusion

Immunohistochemical examination showed that the vaccine strains failed to colonize the internal organs of vaccinated animals, and therefore appear safe to use under field conditions. The vaccines were able to induce the innate response that is critical for the development of a potent acquired immunity. These findings indicate that the vaccinated animals can be differentiated from wild infection, and therefore the vaccines can be used in control programs. Further challenge studies need to be conducted to determine the vaccine protection against *Salmonella* shedding in pigs.

Acknowledgements

We would like to acknowledge the Mitacs-Elevate program and Boehringer-Ingelheim Vetmedica Inc. for funding this project.

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Prediction Of Lysine Content And Availability In Corn DDGS Samples Based On Sample Color Measurements

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Background:
Many swine producers are now including up to 20% corn distillers dried grains with solubles (DDGS) in grower/finisher diets. When properly formulated, diets with DDGS can help reduce feed costs with no adverse effects on growth performance or carcass traits. However, there are still concerns within the swine industry about the variability in DDGS quality based on lysine content and availability which could impact pig performance. For example, co-product color (light versus dark color) can vary from batch to batch and is often considered an indicator of lysine content, with a darker colored product often associated with lower lysine content and availability for the pig. Therefore, part of our research was undertaken to quantity the effects of co-product color on DDGS lysine content and availability.

Objectives:
To explore in vitro techniques and use of co-product colour for predicting the nutritional value of DDGS for swine, with emphasis on lysine content and availability.

DDGS sample collection and analyses completed:
Eighty-four weekly DDGS samples were collected from seven corn-based ethanol plants (12 samples per plant) which supply DDGS to Ontario. Samples were analyzed for dry matter (DM), organic matter (OM), crude protein (CP), lysine, fat, starch, neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent insoluble nitrogen (ADIN), ash, P, Na, K, Mg, and S. Co-product colour was measured on all samples using a Minolta colorimeter based on the CIE, L* a* b* scale [L* = lightness of color (0 = black, 100 = white) with higher values for a* and b* indicating an increased redness and yellowness, respectively]. This included unground (NG) samples and samples ground (G) to < 1 mm particle size. In a subset of 18 samples, lysine and reactive lysine (e.g. lysine with a free ε-amino group) content and Immobilized Digestive Enzyme Activity (IDEA) were also determined in the laboratories of Evonik Degussa and Novus, respectively. Step-wise regression analysis was completed to correlate DDGS colour to lysine content, digestibility and availability.

Results to Date:

- One sample was considered an outlier due to its extremely low total and reactive lysine contents (0.42 and 0.24% respectively). This sample was easily identified by its very low L* value (39.7).

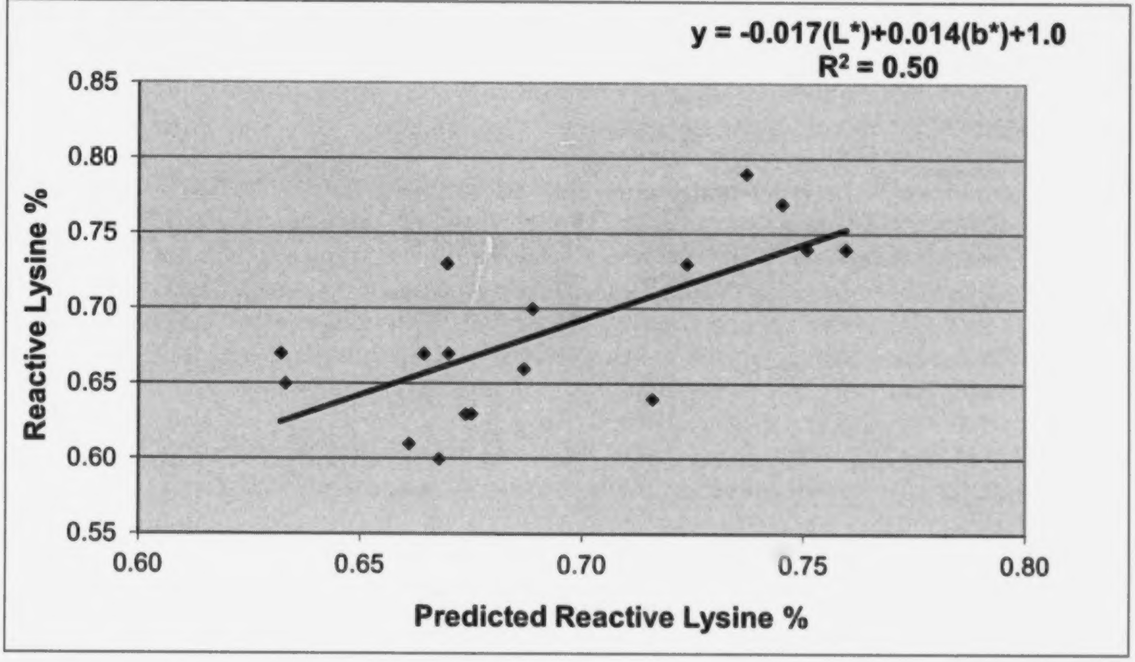
- Lysine content (N=18; mean 0.81%; SD 0.11; range 0.42 to 0.94) was predicted as $y=0.02\times b^*(G)-0.10$ ($R^2=0.59$, $P<0.001$), while inclusion of L*(G) and a*(NG) increased R^2 to 0.86.

- Reactive (available) lysine content (N=18; mean 0.66%; SD 0.12; range 0.24 to 0.79) was predicted as $y=0.02\times b^*(G)-0.32$ ($R^2=0.62$, $P<0.001$), while inclusion of L*(G) and a*(NG) increased R^2 to 0.90. When the outlier sample was eliminated, reactive lysine content (N=17; mean 0.68%; SD 0.06; range 0.60 to 0.79) was predicted as $y=-0.01\times L^*(NG)+1.30$ ($R^2=0.33$, $P<0.05$). The inclusion of b*(NG) increased R^2 to 0.50 (Figure 1).

- Lysine IDEA digestibility (N=18; mean 69.4%; SD 3.14; range 64.0 to 74.0) was predicted as $y=0.35\times b^*(G)+53.1$ ($R^2=0.27$, $P<0.05$), while inclusion of a*(NG) increased R^2 to 0.46.

- Reactive lysine content was multiplied by IDEA digestibility to estimate available lysine content (N=18; mean 0.46%; SD 0.09; range 0.15 to 0.58), which was predicted as $y=0.016 \times b^*(G)-0.30$ ($R^2=0.62$, $P<0.0001$). Inclusion of $L^*(G)$ and $a^*(NG)$ increased R^2 to 0.86. When the outlier sample was eliminated, the estimated available lysine content (N=17; mean 0.48%; SD 0.05; range 0.41 to 0.58) was predicted as $y=-0.01 \times L^*(NG)+1.11$ ($R^2=0.38$, $P<0.001$) while inclusion of $b^*(NG)$ increased R^2 to 0.57.

Figure 1. Observed versus predicted reactive lysine content (%) using L* a* b* colour measurements (N=17). Minolta colorimeter L* and b* values used in the prediction equation were measured on unground samples.



Results and benefits to swine industry:

There was considerable variation in nutrient profiles for the DDGS samples collected for this study. The models above provide a rapid method to estimate the lysine content and predicted availability and digestibility of this essential amino acid based on a limited number of DDGS samples collected. Therefore more samples and analysis would help substantiate the equations developed.

An important observation was the variability in lysine content, which was independent of protein content or other key amino acids. Especially, in samples with an L^* value below 45, lysine content was reduced. The latter should be considered carefully in feed formulation.

Acknowledgements:

The authors would like to thank Ontario Pork and OMAFRA for their financial support of this research project. Cooperation from all participating ethanol manufacturing facilities was also greatly appreciated.

II-16

Impact of Debt on Ontario Swine Farms

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Introduction

The Ontario swine industry has endured poor profitability since at least 2006. As a result, many producers have left the industry while many of the producers remaining in the industry have taken on more debt. This paper is intended to provide some highlights from a report analyzing the debt situation on Ontario swine farms for the period from 2003 to 2009.

Selected Results

Data from the Ontario Farm Income Database (OFID) for farms with at least 50% of their gross revenue from swine sales was used. This data represented 1,343 farms in 2003 which decreased to 777 farms in 2009. It was estimated that the total debt on Ontario swine farms was approximately $1.1 billion in 2009, an increase from the $957 million total in 2003. The average debt per farm changed significantly during this period increasing from $712,767 in 2003 to $1,430,035 in 2009. As a comparison, gross revenue (i.e. total operating revenue) for the industry was $990 million in 2003 and $843 million in 2009. This is an average gross revenue per farm of $737,348 in 2003 and $1,084,681 in 2009. Debt per farm has increased 100% while gross revenue per farm has only increased 47%.

Analysis using OFID was further disaggregated into results by farm size (i.e. gross revenue range) and production type. Table 1 shows a comparison between 2003 and 2009 of the distribution of farm numbers, total industry debt and total industry operating revenues by gross revenue range. For example, farms with greater than $1,000,000 in gross revenue accounted for 16% of the swine farms but 53% of the total industry debt and 63% of the total industry operating revenues in 2003. By 2009, this group accounted for 30% of the farms, 60% of the total industry debt, and 74% of the total industry operating revenues.

Table 1. Share of Number of Farms, Total Industry Debt and Total Industry Operating Revenues by Gross Revenue Range, 2003 vs. 2009.

	Number of Farms		**Debt**		**Operating Revenues**	
Gross Revenue Range	**2003**	**2009**	**2003**	**2009**	**2003**	**2009**
$0 - $100,000	13%	6%	2%	1%	1%	0%
$100,000 - $300,000	31%	18%	10%	6%	8%	3%
$300,000 - $500,000	20%	21%	13%	11%	10%	7%
$500,000 - $1,000,000	19%	24%	22%	22%	18%	16%
>$1,000,000	16%	30%	53%	60%	63%	74%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Calculations using the Ontario Farm Income Database, OMAFRA.

Table 2 shows a comparison between 2003 and 2009 of the distribution of farm numbers, total industry debt and total industry operating revenues by production type. For example, farrow to finish farms accounted for 44% of the swine farms, 41% of the total industry debt and 38% of the total industry operating revenues in 2003. By 2009, this group accounted for 48% of the farms, 48% of the total industry debt, and 43% of the total industry operating revenues.

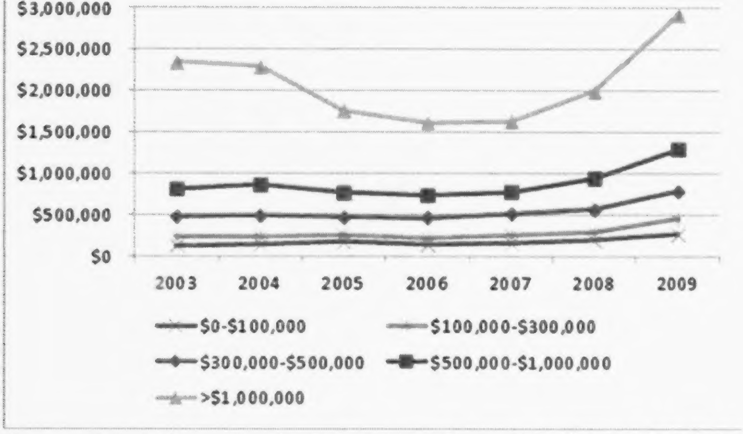
Table 2. Share of Total Industry Debt and Operating Revenues by Production Type, 2003 vs. 2009.

	Number of Farms		**Debt**		**Operating Revenues**	
Production Type	**2003**	**2009**	**2003**	**2009**	**2003**	**2009**
Farrow to Feeder	7%	13%	10%	17%	8%	14%
Farrow to Finish	44%	48%	41%	48%	38%	43%
Farrow to Wean	8%	7%	17%	8%	12%	5%
Mixed Production	3%	6%	6%	5%	8%	12%
Finish	38%	27%	26%	22%	34%	26%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Calculations using the Ontario Farm Income Database, OMAFRA.

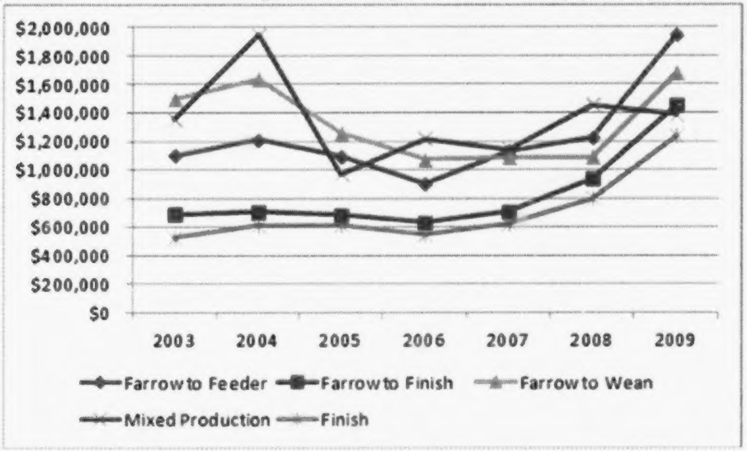
Figure 1 provides a comparison of the average estimated debt per farm by gross revenue range from 2003 to 2009. Figure 2 provides a comparison of the average estimated debt per farm by production type from 2003 to 2009. It is apparent in both charts that the trend appears to be that the average debt per farm declined from 2003 to 2006 but the financially difficult years from 2007 to 2009 caused the average debt per farm to increase significantly in some farm categories. For example, farms in the $500,000 to $1,000,000 gross revenue category experienced an increase in average debt per farm from $742,377 in 2006 to $1,305,121 in 2009 while farms in the greater than $1,000,000 gross revenue category increased from $1,614,219 in 2006 to $2,928,081 in 2009. Farrow to finish farms saw the average debt per farm increase from $629,972 in 2006 to $1,453,854 in 2009.

Figure 1. Estimated Debt per Farm by Gross Revenue Range, 2003-2009.



Source: Calculations using the Ontario Farm Income Database, OMAFRA.
Notes: Estimated debt = interest expenses ÷ (historical bank prime rate + 1%).

Figure 2. Estimated Debt per Farm by Production Type, 2003-2009.



Source: Calculations using the Ontario Farm Income Database, OMAFRA.
Notes: Estimated debt = interest expenses ÷ (historical bank prime rate + 1%).

Selected Key Findings

- Estimated debt per farm has increased significantly from 2003 to 2009, especially during the 2007 to 2009 period.
- There is a lot of variability within the data. Often more variability exists within categories than between categories (i.e. different farm sizes or production types).
- Profitability is not necessarily related to debt level, farm size or production type.
- On an aggregate industry level, debt levels and debt servicing requirements on average do not appear to be the major determining factor in profitability. However, looking at data disaggregated into five quintiles showed that there are farms that are doing very well financially (i.e. top 20%) while there are farms that are struggling (bottom 20%), regardless of the year, farm size or production type.
- The ability to maintain a debt level that is balanced with the farm's ability to generate revenue and control costs is important. The ratio or balance of total debt to total revenue will be unique to each farm due to the many other variables (i.e. management, productivity, importance of off-farm income, etc.) that can affect profitability.
- Sensitivity analysis showed that the estimated impact of a 2% interest rate increase would have resulted in additional interest expenses of $2-$3 per pig sold.

The entire report is available at:
http://www.ridgetownc.uoguelph.ca/research/documents/mcewan_AMI_Swine_Farm_Debt_-_Final.pdf

Acknowledgements

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Thank you and appreciation is extended to Ontario Pork for their support.

Management Of Pest Flies In Swine Production

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The Problem

Flies are more than an irritation for animals, workers, and neighbours. They affect the health and comfort of animals and reduce feed intake, impacting weight gains. Flies can spread bacterial and viral diseases, such as the porcine reproductive and respiratory syndrome virus, increasing threats to human health as well as veterinary costs. Accumulation of manure and organic material provides food for most of the adult and larvae, attracts the female for egg-laying and constitutes the habitat of developing fly maggots. Intensive and confined pig production produces an ample source of feed for flies and potential breeding sites, mainly during May to September.

The house fly (*Musca domestica*) is the major pest problem for the swine industry. It is a 6-9 mm long, grey and black fly with four black stripes on its thorax. It is a non-biting fly. The specks it leaves on surfaces can foul the environment and contaminate carcasses. The breeding sites are debris, manure piles, animal bedding and spilt feed (hay, grain, silage). The biting stable fly (*Stomoxys calcitrans*), also present, has a gray abdomen and piercing mouthparts. It is a biting fly and often attacks legs and bellies.

In warm humid conditions (> 29°C) the life cycle may take 9-10 days compared with 21-28 days when it is cooler (21°C). An adult female can lay 100 or more eggs every 4 days for up to 3 weeks and generally up to 500 eggs in a lifetime. Eggs hatch within hours if conditions are right (60%-80% moisture, high temperature). Maggots feed on fresh or decomposing organic matter and pupate within 6-7 days to emerge as adults 5-6 days later. There can be 8-10 fly generations in a year. Flies can disperse over considerable distances.

CONTROL OPTIONS

Little information is available for management of pest flies in commercial swine production. In contrast, strategies for control of pest flies in poultry and cattle production have been studied extensively. Some results from research in other animal production can be use to outline solutions for swine producers. A multi-prong approach usually gives the best results.

Physical methods

Good sanitation to prevent the breeding of flies is the key for management; keep areas clean and dry. Remove breeding sites (manure, spilt feed, bedding) once a week or more frequently to break the life cycle of the fly. Check for water leaks: waterers should be checked daily. Ventilate to ensure good air circulation which can reduce manure moisture to below 50% and discourages flies from laying eggs. Turn compost piles to ensure heating which will kill eggs and maggots. Maintain a fly free zone in the facility, with screen doors and windows, and keep in-out traffic to a minimum. Traps are effective for reducing adult fly numbers, especially inside buildings. The most economical sticky traps are usually the "clothes line" type such as Sticky Roll ™ but they are also sold under other brand names. Electrocutor traps can be effective, but should be used with extreme caution because there is a danger of spreading pathogens carried on the surface of the fly exoskeleton when it disintegrates.

Biological control agents - parasites and predators

Parasitic wasps (mainly *Muscidifurax* spp.and *Spalangia* spp.) occur naturally in the barn vicinity. They lay eggs in fly pupae and an adult wasp will emerge instead of a fly. They are not as prolific as the flies and have a slower rate of development. Natural populations must be augmented by frequent releases (every 1-2 weeks) of large numbers. Parasitic wasps are available commercially for use in all types of livestock operations and are shipped as parasitized pupae in wood shavings. You need to start the releases early (late May in most regions) and continue until mid September or until the fly season is over. Nematodes (e.g. *Steinernema feltiae*) are applied to infested breeding sites (hot spots) to control maggots. Effectiveness of biological control agents against house and stable flies was shown to be highly variable depending on animal type, climate, type of manure/bedding, species released, indoor or outdoor locations.

Use of insecticides (natural or synthetic)

Many natural products or synthetic insecticides can be added to surfaces (e.g. walls) to control pest flies. For example, diatomaceous earth and lime added to the manure may help in reducing the number of flies. Synthetic insecticides available to control flies inside swine facilities are usually applied to vertical surfaces, and will have a persistent effect (a few days to a few weeks). Flies resting on treated surfaces will absorb the insecticide. Other chemical options include: baits, space sprays, larvicides and animal sprays. Larvicides applied to manure are not recommended because they will interfere with biological control agents and large amounts would be needed. Fly baits are an interesting option when the fly levels are low. The development of resistance to insecticides can be rapid, leading to control failure. Follow label directions and use only after other methods have failed.

Essential oils applied to surfaces and to the animals (dairy) have been found to repel flies for a few hours to several days. Products such as peppermint, basil, pine, lemongrass and geranium have shown acceptable repellence in laboratory and field tests. However, the short life of the essential oils and limited amount of research is still restricting their use. Research is ongoing at the University of Guelph-Campus d'Alfred. All products sold to control or repel pests must be registered by the Pest Management Regulatory Agency (PMRA).

The bottom line

Manure management and farm hygiene in and around facility areas are key to eliminating or decreasing the fly breeding sites. Exclusion methods, such as screened doors and ventilation openings can delay fly colonization of facilities or rooms. Parasitic wasps can contribute to 50% fewer flies when used in combination with adequate manure removal or management. Insecticide use should be a last resort. Monitoring the fly population, by using sticky cards and/or spot cards (and counting fly specks) can indicate surges in population levels, the need to apply a control method or if the management strategies applied are efficient. Other baited traps can be purchased to monitor the population. It is also important to keep animals healthy, as they will be less affected by diseases and flies.

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Investigation of Meloxicam Given to Sows at Parturition with Respect to Improving Performance and Reducing Pain

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Reason for the study

Pre-weaning mortality is an important issue in pig production. Crushing of piglets by sows is a major cause of mortality, with most deaths occurring within the piglets' first 24 hours of life[1]. Although farrowing crates were introduced to reduce crushing, losses estimated between 4.8 and 18% due to crushing are still evident[1]. Thus, piglet crushing is still a major problem in today's industry and a major source of economic loss.

Piglets are faced with difficult nutritional challenges soon after birth. They must quickly gain access to a teat and consume colostrum within the first 24 hours of life in order to obtain sufficient energy supplies and protection from disease. However, piglets are often crushed while in close proximity to the sow when suckling and massaging the udder[1].

Analgesics such as meloxicam, a relatively long-acting non-steroidal anti-inflammatory drug (NSAID), are becoming licensed for food animals. Administering analgesics to sows at farrowing may alleviate some pain and allow them to lie more restfully, allowing the piglets more opportunity for colostrum intake without the risk of being crushed.

The objective of this trial was to determine the efficacy of meloxicam administered to sows at the time of parturition with regard to nursing behaviour and piglet survival and growth.

Materials and Methods

The study comprised of 289 litters and 3006 piglets. Sows were randomly allocated to receive a single intramuscular injection of one of the following treatments within 12 hours of farrowing: injection of 0.4 mg/kg meloxicam or injection of 0.4 mg/kg placebo. All piglets were weighed at birth, at castration and tail-docking at 5-7 days-of-age, and at 19-21 days-of-age prior to weaning. Mortality data were collected daily. A total of 20 blood samples were collected from sows at farrowing and 4-6 hours post-farrowing for determination of cortisol concentrations. HOBO data loggers were used on a total of 43 sows to record position changes for the first 24 hours after farrowing. Temperature readings were taken on a total of 30 sows at treatment, 4-6 hours post-farrowing, and at 24 hours post-treatment in addition to feed intake scores. The data analysis from the present study on plasma cortisol levels and HOBO data loggers is ongoing.

Results

There was not a significant difference between treatment groups with respect to average daily gain (ADG). Piglets of sows that received meloxicam grew an average of 234.8±65.6 g/day and piglets of sows who received the placebo grew an average of 231.9±68.0 g/day (P=0.17). Maximum piglet ADG values of 415g/day and 442g/day were observed for sows receiving meloxicam and sows receiving the placebo. There was not a significant difference between treatment groups with respect to mortality rate with 11.59±0.31% mortality in the meloxicam group and 10.54±0.32% in the placebo group (P=0.36).

Different causes of mortality have not yet been analyzed. No significant difference was observed between treatment groups with respect to rectal temperatures of the sows at treatment ($P=0.85$), 4 to 6 hours after farrowing ($P=0.52$), or 24 hours after farrowing ($P=0.42$). There was not a significant difference of feed intake 24 hours post-treatment between treatment groups ($P=0.98$). The analysis of the more detailed studies determining reaction to pain is pending.

Discussion

It can be concluded that meloxicam did not cause any negative effects based on the growth rate and mortality results gathered and we conclude that it is a safe analgesic to use in sows at farrowing. The results suggest that production performance is not improved through the routine administration of meloxicam to all sows at farrowing. Production performance is affected by a variety of individual and environmental factors and may not be a good measure to determine whether meloxicam did reduce pain and made the sow more comfortable immediately after farrowing. It is possible that some sows may find the post-farrowing experience more stressful. For example a glit that required manual assistance to deliver large piglets might benefit more from analgesia than an older sow following a relatively quick and uneventful farrowing.

Blood cortisol levels may be used as an objective indicator of stress and pain. Behavioural observations may also be used in assessing pain, but measurements tend to be subjective and there is much individual variation. Currently, there is no ideal method of measuring the effectiveness of pain control.

The use of analgesics to alleviate pain immediately after farrowing may be a useful tool for a subset of animals, and this area will require further study.

Acknowledgements

This work was supported by Boehringer Ingelheim and Ontario Pork. We gratefully acknowledge the AHL and personnel at the swine farm for their valuable assistance with this project.

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Does Non-Specific Maternally-Derived Immunity Or PCV2 Viremia Adversely Affect PCV2 Vaccination Response?

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Introduction

Porcine circovirus type 2 (PCV2) vaccines reduce mortality and morbidity associated with PCV2 infections. Vaccination is common on North American swine operations and a wide range of off-label protocols are used. In Canada, 60% of producers reported using PCV2 vaccines off-label with little data regarding how this extra label use affects vaccine efficacy.[1] Veterinarians and producers cite pre-vaccination PCV2 infection (viremia) and passively derived PCV2 antibodies as adversely affecting vaccine success.

Few studies have investigated the impact of non-specific maternally derived IgG concentrations and pre-existing PCV2 viremia on a pig's response to *Mycoplasma hyopneumoniae* (*M. hyo*)/PCV2 vaccination. Information on factors positively or negatively affecting PCV2 vaccination response is needed to ensure that swine practitioners design optimal vaccine protocols for their producers. This investigation was performed on 135 piglets from each of two commercial swine herds. Differences in post-vaccination PCV2 specific antibody titers, average daily gain (ADG) and mortality were compared between: 1) piglets with high and low PCV2-specific antibodies at the time of PCV2 vaccination; 2) neonatal piglets with high and low immunoglobulin G (IgG) determined by radial immuno-diffusion[1]; and 3) piglets with or without PCV2 viremia at the time of PCV2 vaccination.

Material and Methods

Herd 1 is a Porcine Reproductive and Respiratory Syndrome virus (PPRSv) positive, *M. hyo* positive, 400 sow farrow-to-finish operation that uses a one dose combination vaccine for *M. hyo* and PCV2. Herd 2 is a PRRSv negative, *M. hyo* positive 600 sow farrow-to-finish operation using a two dose combination *M. hyo* and PCV2 vaccine. On both farms, 135 piglets at 2 to 4 days of age were ear notched, weighed and blood sampled. Prior to initial PCV2 vaccination and three weeks after final PCV2 vaccination all surviving piglets were weighed and blood sampled again. Sera were tested for colostral antibodies[2] (on the first blood sample only), PCV2[3] viremia, PRRS viremia[4] (Herd 1 only) and PCV2-specific antibodies[5]. Production data including mortality and ADG from birth to 160 (were the pigs actually this old?) days of age was recorded. Statistical analyses to test for associations between the above factors were performed independently by farm.

Results and Application to Practitioners

Sample collection is complete except for final weights. Sera was submitted to diagnostic laboratories and some results are pending. There was no correlation between serum IgG concentration (RID value) and PCV2 ELISA titres for piglets sampled at 2 to 4 days of age (Herd 1 $r^2=0.03$; Herd 2 $r^2=0.13$). Correlations between colostral antibodies (IgG) and PCV2 ELISA antibodies were plotted by litter by herd (n=7 litters per herd), poor in all litters (Herd 1 $r^2<0.07$; Herd 2 $r^2<0.16$), except in three litters in Herd 2 with r^2 values of 0.5, 0.4 and 0.3.Correlations were also very weak (r-squared values less than 0.05 in both herds) when PCV2 antibodies were regressed on birthweight. These findings from the interim data analyses suggest that birth weight and maternally derived IgG values, and PCV2 ELISA s/p ratios and maternally derived IgG concentrations are not correlated in the two herds participating in this study. The poor correlation between IgG concentration and PCV2 s/p ratios was unexpected.

Once data analyses have been completed, this study will provide useful information on whether commonly cited factors for extra-label PCV2 vaccination protocols are justified. By identifying factors that positively or adversely affect PCV2 vaccination response, veterinarians can ensure that PCV2 vaccinations result in optimal immune responses; thereby improving swine health and reducing the use of antibiotics to fight secondary bacterial infections.

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by phone 905-741-2032 or by mail at 6484 Wellington Road 7, Unit 10 Elora Ontario N0B 170.

Is Tilmicosin Useful In Reducing Viremia And The Clinical Impact Of Porcine Reproductive And Respiratory Syndrome?

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Introduction

Porcine reproductive and respiratory syndrome (PRRS) is the most important swine disease in Canada today. A common strategy for controlling PRRS in a breeding herd is to inoculate pregnant sows with serum from a viremic pig in order to create uniform exposure and develop herd immunity rapidly. The procedure generally results in expression of clinical disease in some of the inoculated sows. It has also become common practice to medicate the sow herd with antibiotics during this controlled exposure to the disease with the intention of controlling secondary bacterial infection. There have been anecdotal reports that tilmicosin has become the preferred option and this is based on a belief that the antibiotic has antiviral properties.

Objectives

The objectives of this study are to determine if feed medication with tilmicosin reduces viremia in pigs exposed to PRRS and to determine the effect of tilmicosin on lung pathology and macrophage activity.

Methods

Two hundred pigs were randomly assigned to 1 of 5 treatment groups: Negative control: receiving feed containing 400ppm of tilmicosin but not infected with PRRS virus, Negative-negative control: receiving non-medicated feed and not infected with PRRS virus, Positive control: infected with PRRS virus but not receiving tilmicosin, and 2 groups that are both infected with PRRS virus with one group receiving feed containing 200 ppm of tilmicosin, and the other receiving feed containing 400 ppm of tilmicosin. Clinical signs and body temperature were recorded daily. Quantitative PCR was performed on sera to assess viremia and tilmicosin serum concentrations were determined using HPLC. Pulmonary alveolar macrophages were isolated from the broncheo-alveolar lavage fluid of 20 pigs to evaluate the effects of tilmicosin on macrophage activity across the different groups. A postmortem was performed on 10 pigs including histology and immunohistochemistry on lungs for PRRS and the lung levels of tilmicosin was determined.

Results to Date

Statistical analysis and results are pending.

Take Home Message

This project will benefit pork producers either by saving them money on drug costs or if tilmicosin is partially effective, then reducing losses during a PRRS outbreak.

Acknowledgment

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Mycotoxin Levels in Liquid Feed May Escalate during Fermentation

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Background

Deoxynivalenol (DON, Vomitoxin) is a trichothecene mycotoxin produced by some species of the fungus *Fusarium*. It is often found as a contaminant of cereal crops such as wheat and corn, which are main ingredients of swine feed.

The effect of feeding fermented liquid feed on swine growth performance varies greatly, which may be contributed in part by variations of mycotoxins (Canibe et al. 2010). Many factors affect the amount of mycotoxins (e.g. DON) in fermented liquid feed, including populations of microbes and levels of lactic acid or acetic acid (Franco et al. 2011; Li et al. 2011).

Objectives

1) To investigate effect of natural occurring microflora on DON content during liquid feed fermentation.
2) To investigate changes of organic acids during liquid feed fermentation.

Results and Discussions

1). DON levels increased during a 72-hour fermentation of DON contaminated corn. Corn containing 6.8 ppm (µg/g) DON was mixed with water (corn:water 1:2) and left to ferment in a plastic container for 72 h. As shown in Figure 1, at 25 °C, the DON level increased significantly in the non-heated corn (Normal) with time, particularly after 48 h. DON level also increased, but only slightly, when the corn was autoclaved at 121°C for 15 min (Autoclaved) in an attempt to inactivate natural occurring microbes before the start of fermentation. Increases in DON contents were higher at 37 °C than at 25 °C. This implies that DON producing fungi produce DON during fermentation and the autoclave treatment is not effective in killing heat resistant *Fusarium* spores.

2). Organic acid levels increase during liquid fermentation of corn. As shown in Figure 2, although lactic acid levels in both the normal and autoclaved corn increased with time, the extent of the increase was much greater in the normal corn for both incubation temperatures of 25°C and 37°C. The results indicate that lactic acid is produced during fermentation, most likely by lactic acid bacteria in the corn, and that autoclaving significantly reduces the populations of these microbes.

During fermentation levels of acetic acid were much lower than lactic acid levels, increased only slightly during the 72 h incubation at both 25°C and 37°C, and were not influenced by autoclaving. The populations of acetic acid producing microbes appear small and were heat resistant.

Conclusions and Take Home Messages

DON can be produced by natural occurring microbes, e.g. *Fusarium* fungus, during fermentation of contaminated corn, resulting in increased DON levels in liquid feed. Increased levels of organic acids might lower the pH of fermented liquid feed, thus protecting DON from microbial degradation. Strategies need to be developed to effectively control DON not only in raw feed ingredients, but also during liquid feed fermentation.

Acknowledgements

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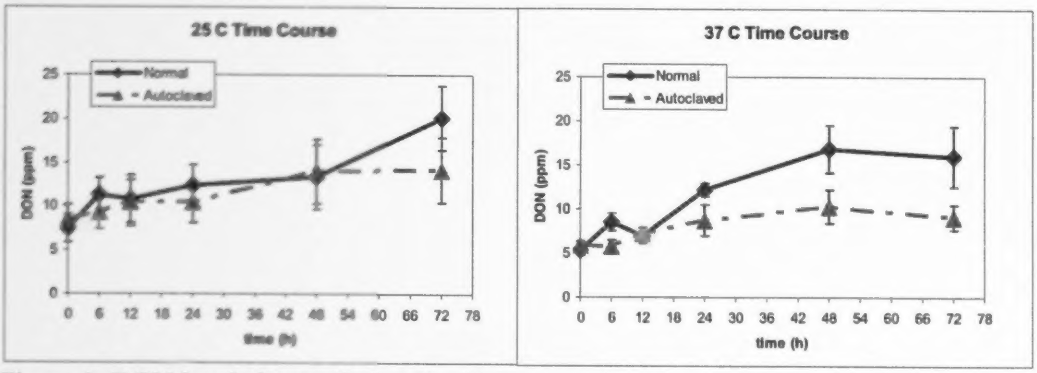

Figure 1. DON level change during liquid fermentation of corn.

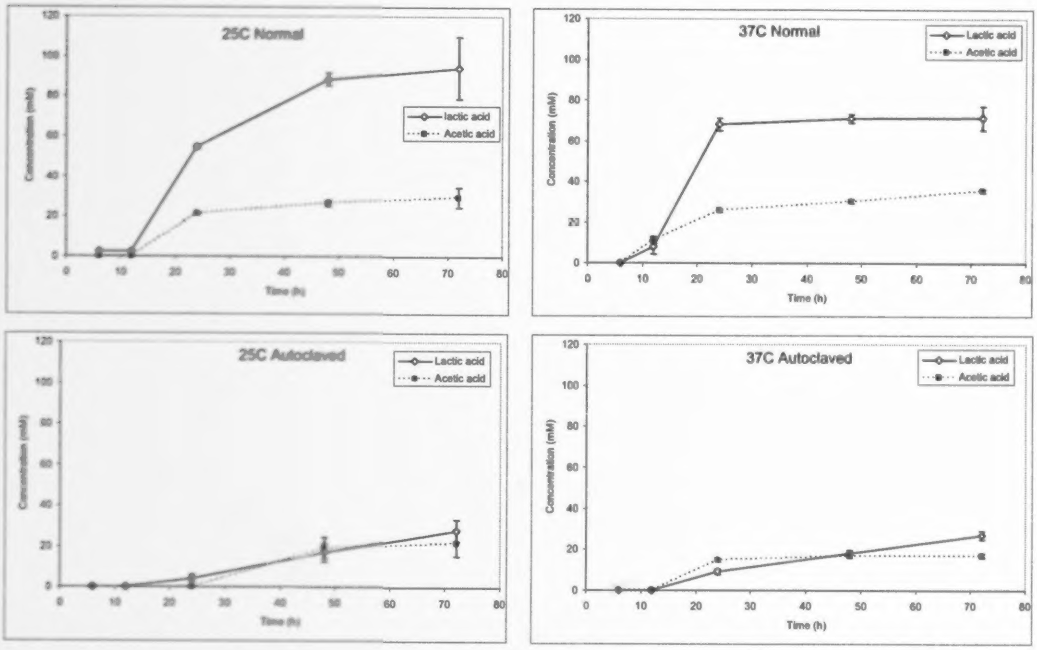

Figure 2. Lactic acid and acetic acid level change during liquid fermentation of corn.

Evaluation Of External Biosecurity Practices On Southern Ontario Swine Farms

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Introduction

Biosecurity is becoming increasingly important in the North American swine industry, where large-scale production and an industrialized model amplify the potential impact of disease introduction and spread. The objectives of good biosecurity practices include reducing or eliminating specific pathogens, reducing antimicrobial use, improving productivity, and achieving a higher health status for livestock which, ultimately, results in safer pork products for human consumption and in a safer working environment for producers (1). Bio-exclusion, also known as external biosecurity, is defined as the biosecurity protocols that are aimed at preventing the introduction of new pathogens to the farm environment (2). The majority of farms focus on external biosecurity measures and allocate a large proportion of resources for this purpose (3).

Although biosecurity at the individual farm level is frequently assessed, efforts to summarize this information and provide an overview of biosecurity practices are relatively infrequent. This type of work has not yet been accomplished for swine herds in southern Ontario, however studies from Belgium, Denmark, Wales, and Quebec have used herd-level information to determine the best number of groups or factors to describe biosecurity practices on livestock farms, as well as to describe the characteristics of the identified groups/factors (1, 4-6).

Objectives

The objectives of this portion of our project are: (i) to determine the best number of external biosecurity groups to describe our sample of southern Ontario swine herds, (ii) to describe the identified groups in terms of their major characteristics, and (iii) determine which variables are most important in differentiating the groups from one another.

Methods

Data for this study were obtained from the Ontario Porcine Reproductive and Respiratory Syndrome (PRRS) Surveillance Survey. These data were collected in 2007 and included 377 swine herds. A subset of variables pertaining to external biosecurity practices were selected for analysis using two methods: two step cluster analysis and latent class analysis. Agreement between the two methods was assessed using the kappa statistic. Descriptive statistics allowed the authors to name the identified external biosecurity groups and to describe the groups in terms of their major characteristics.

Results and Discussion

Our sample was best described by four external biosecurity groups. The most important variables in differentiating the groups from one another related to trucking protocols. The four groups and their major characteristics are described below.

1. High biosecurity herds that are open with respect to replacement animals (n=151). Herds in this group had high trucking standards for live animals and good entrance sanitation procedures for employees and visitors. One area of concern we identified was that a relatively high proportion of these herds reported that trucks picking pigs up from the farm were not always disinfected prior to arrival.
2. High biosecurity herds that are closed with respect to replacement animals (n=65). The large majority of farms in this group were closed herds, thereby limiting the primary source of

pathogen introduction. Herds in this group had good trucking standards and entrance sanitation protocols in some areas, but required improvement in other areas.

3. Moderate biosecurity herds (n=96). This group was determined to be of moderate biosecurity because although they did well in some aspects of trucking, there were other areas that required improvement. The majority of these herds were open with respect to replacement animals.
4. Low biosecurity herds (n=65). Herds in this group were open with respect to replacement animals and required improvement in terms of trucking and entrance sanitation protocols for employees and visitors.

The finding that a large proportion of our sample of swine herds belonged to one of the two high biosecurity groups is encouraging. Some important areas of external biosecurity were not being implemented at the time of data collection, however improvements have likely been accomplished in recent years. This is due to an increased focus on the importance of biosecurity protocols, as well as the training that is now available to producers and veterinarians.

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Swine Dysentery and Other Emerging Brachyspiras

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Introduction

After a decade or more of relative quiescence, bloody mucoid diarrhea associated with a necrotizing and haemorrhagic colitis in finisher pigs has re-emerged in both Canada and the US in the last several years. Many of the cases, particularly in the USA, are associated with *B. hyodysenteriae (Bhyo)*, the most common cause of haemorrhagic colitis in pigs. This disease is known by convention as swine dysentery. Swine dysentery can be an economically devastating disease. By recent estimations[1, 2] the cost of dysentery is between $7 and $16 per pig, due to additional medications and/or loss of grow-finish performance.

The cardinal clinical signs of swine dysentery are bloody and mucoid diarrhea of grower and finisher pigs. The severity of diarrhea may vary and often mucous is more prominent than blood. While traditionally a disease of high mortality, mortality levels are more variable in recent outbreaks. Some strains of *Bhyo* however, are more virulent than others, and some strains may inhabit the intestinal tract but cause no disease at all[3]. Although swine dysentery is generally reported as a disease of finisher pigs, all pigs are susceptible to *Bhyo* but disease is rarely seen in pigs younger than 12 weeks. Diagnosis in sow herds is very difficult due to the more subtle clinical signs and low prevalence of shedding in the manure of adult animals. Breeding herds however may be a reservoir of infection and should be worked up if implicated by the occurrence of swine dysentery in downstream herds or flows.

The *Brachyspira* genus

One other *Brachyspira* sp. commonly affects pigs three months of age and older. *B. pilosicoli (Bp)* causes spirochetal colitis, seen clinically as a "wet-cement" type diarrhea in grower and finisher pigs. At this time, it is not generally considered a production limiting disease so positive diagnosis is of little practical importance. Several other species may be detected periodically from pigs but their clinical significance is less certain. *B. innocens (Binn)* and *B. intermedia (Bint)* are generally considered non-pathogenic. *B. murdochii (Bm)* has only recently been associated with mucoid diarrhea[4], and *B. suanatina* has been linked with a dysentery-like disease in both pigs and mallard ducks in Europe[5].

Brachyspira spp. infect many species including chickens, rats, mice, and water fowl; all of which can be potential environmental reservoirs of infection for pork farms. In addition, *Brachyspira* spp. survive for lengthy periods in the environment, and particularly in slurry. *Bhyo* is extremely contagious, and difficult to eliminate from farms once infected. In theory, operating with high biosecurity standards should be sufficient to prevent the introduction of *B. hyodysenteriae*, but many high health herds have in fact broken with swine dysentery indicating lapses in biosecurity have occurred.

Re-emergence and identification of a novel *Brachyspira* sp.

From the mid-1990's through 2003, swine dysentery was rarely diagnosed and some speculated that it had been eliminated from North America. Since 2003, the US south-east and mid-west have seen an exponential increase in swine dysentery cases. In western Canada, swine dysentery was virtually absent until 2010, but sporadic cases have been diagnosed in the last 12-15 months at Prairie Diagnostic Services Inc. Moreover, our research group at the Western College of Veterinary Medicine (WCVM) has recently investigated several cases of swine dysentery-like illness (i.e. severe mucohaemorrhagic typhlocolitis) unrelated to *Bhyo* and *Bp*, and have identified a novel *Brachyspira* sp. (temporarily named: ***Brachyspira* sp. Sask30446**) in intestinal tissue and feces of affected pigs (Figure 1). In affected farms, the bloody diarrhea affects grower and finisher hogs, and is clinically and pathologically indistinguishable from swine dysentery caused by *Bhyo*. The diarrhea may or may not result in mortality and it responds variably to antimicrobials. Continuous, pulse and prophylactic medications have been used with some success, as have different injectable products. The modes of entry onto these farms have not yet been definitively identified.

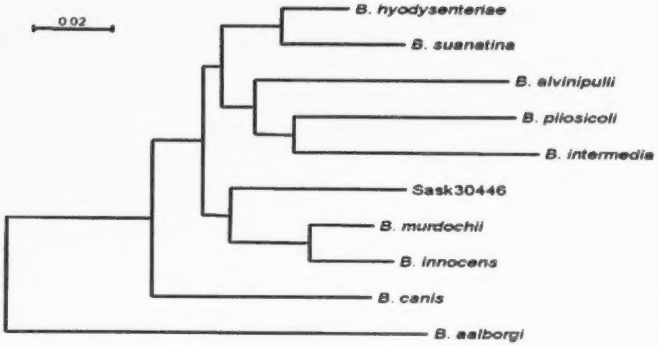

Figure 1. Phylogenetic tree of an 810 bp nox1 gene sequence from colitis cases and published reference sequences.

Case-control studies

Two small pilot case-control studies have been performed to contrast the pathological and microbiological findings of affected and non-affected pigs. On each farm 2-3 affected (case) and 2 non-affected (control) pigs were examined. All pigs examined were non-medicated, except for one case pig in one of the farms. All case pigs suffered swine dysentery-like disease (Figure 2). No clinical signs or lesions were identified in control pigs.

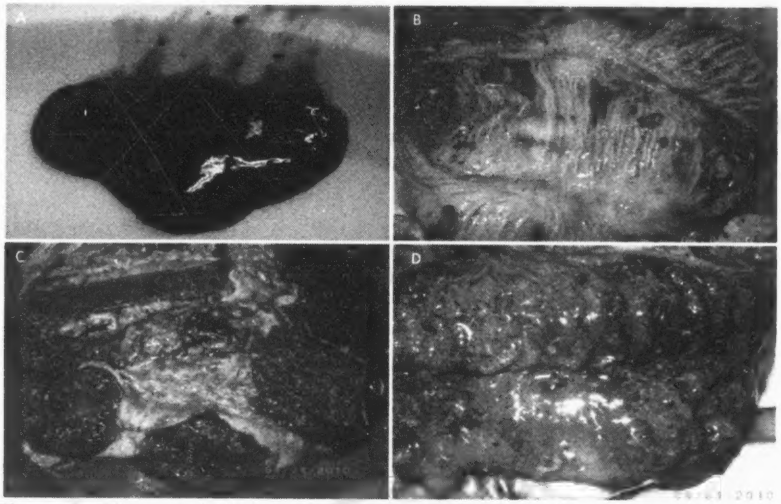

Figure 2. Characteristic intestinal contents (A), colonic mucosa of pigs without (B) or with mucohaemorrhagic colitis (C,D) from affected farms.

Intestinal tissue from all pigs tested negative for *Bhyo*, *Bp*, *Binn* and *Lawsonia intracellularis* (Li; ileitis) by PCR. Salmonella cultures of pooled intestinal tissues were inconsistently positive in 1 of 3 affected and 1 of 2 non-affected pigs in one farm only. Abundant *Brachyspira*-like organisms were identified by direct examination of colonic mucosa of affected, but not in non-affected pigs.

A quantitative PCR assay specific for *B*. sp. Sask30446 has been developed. Relatively high levels of *B*. sp Sask30446 (105 to 108 per gram of tissue/contents) were present in the colon and colon contents of affected pigs, consistently with the lesions observed. *B*. sp Sask30446 was either not detected in non-affected pigs, or was detected at very low, non-quantifiable levels.

Diagnosis

The presence of clinical signs and gross pathological lesions confined to the colon and caecum is highly suggestive of *Brachyspira*-associated colitis, including swine dysentery. Additional laboratory testing is required however, to differentiate *Brachyspira*-associated colitis from other intestinal diseases including salmonellosis and ileitis, the main differentials in western Canada. In the laboratory, PCR (used to detect bacterial DNA), direct smears, culture and histopathology are all used in the diagnosis of potential cases. Culture requires specialized techniques and media and is only performed in labs specialized in the art. Numerous PCR assays are available; some specific to a selected species, and other generic to the *Brachyspira* genus. Testing for the novel *Brachyspira* sp Sask30446 is performed on a fee for service basis by our research group at WCVM on tissue from affected animals with bloody diarrhea that has tested negative for *Bhyo* and *Bp*. Testing feces from normal or diarrheic animals is not always rewarding.

Control and treatment

Feed and water medication are the primary modes of treatment for herd outbreaks. Individual animals may also benefit from injectable medications if severe. Relapses are common after withdrawal of medications in both individual animals and in populations. Adequate sanitation is essential for prevention and helps to reduce infection pressure, but does not eliminate *Brachyspira* spp. from infected premises. There is presently no vaccine available. Once infected, rodent populations and slurry remain long-term reservoirs. Thus, the best cure is prevention through adequate external biosecurity.

Discussion and Implications

Swine dysentery is rare but not absent in western Canada. Our current research indicates a compelling association between relatively high levels of *Brachyspira* sp. Sask30446 and colitis, and additional work is underway to determine if *B.* sp. Sask30446 is causal. While the bacterium is cultivatable in vitro, it is clearly genetically different from the known *Brachyspira* spp. infecting swine. Thus, commercial PCR assays used for the diagnosis of traditional known *Brachyspiras* are unlikely to detect this novel species. Therefore, diagnostic labs and veterinarians should be aware that not all cases of mucohaemorrhagic diarrhea in swine appear to be associated with *Bhyo*. If diagnostic results from appropriately submitted cases of bloody diarrhea are negative for *Bhyo*, additional testing for novel strains should be performed.

Key points:

- Swine dysentery has re-emerged in North America, including western Canada, after close to a decade of quiescence. Traditionally, this disease is economically devastating.
- Producers are advised to ensure external biosecurity measures are adequate to prevent entry into their units. This is a manure-borne disease, easily transmitted on fomites and live pigs.
- Swine dysentery is extremely difficult to diagnose in sow herds, and is rarely clinically evident in sows or nursery pigs. Absence of bloody diarrhea in sows does not necessarily mean a sow herd is negative.
- A potentially novel *Brachyspira* species, temporarily named *B.* sp. Sask30446, associated with swine dysentery-like diarrhea has been discovered by our research group at the University of Saskatchewan. Pigs with bloody diarrhea that test negative for *B. hyodysenteriae* should be tested for this novel species. Our research is ongoing.

Acknowledgements

Funding for this research was generously provided by Saskatchewan Agriculture and Food made available through the WCVM Disease Investigation Team, and the Canadian Swine Health Board. The authors also thank the producers for their contribution of diagnostic cases, and collaborating diagnosticians and technicians at Prairie Diagnostic Services Inc. and the Iowa State University.

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Development of Diets for Low Birth-Weight Piglets to Improve Post-Weaning Growth Performance and Optimize Net Returns to the Producer

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SUMMARY

An experiment which utilized 17 weeks of production was designed to examine the response of weanling pigs to diet complexity. Piglets were divided at weaning (28 days) into heavy or light bodyweights and fed either a simple diet for 14 days or a complex diet for1 or 4 days, followed by the simple diet. Feeding the complex diet for 4 days improved growth performance for the first week following weaning when compared to feeding it for 0 or 1 day. Pigs which were lighter at birth, lost less body weight at weaning, and showed a greater positive response to the complex diet than heavier birth-weight pigs. Phase 1 diet could be used more efficiently and cost effectively by targeting it specifically to the lighter pigs at weaning.

INTRODUCTION

Variability in growth is a cost to commercial pork production, especially those utilizing all-in-all-out production systems. In a recent study at PSCI with a large number of litters, we observed an average birth weight of 1.4 kg, however the range was from 0.40 kg to 2.50kg. The smaller birth weight piglets in this study (defined as piglets 0.85 grams or less at birth) failed to demonstrate any evidence of compensatory growth, and their rate of gain lagged behind their larger cohorts throughout all stages of growth, resulting in an additional10 days to reach market weight. Weaning diets, which are expensive, are designed to safely transition the piglet from the liquid milk diet to a solids diet. They are typically complex and contain ingredients providing benefits beyond basic nutrient consideration. We hypothesized that light-weight piglets would show a relatively greater response to a high-quality weaning diet, specifically one containing blood products, than their heavier birth-weight counter-parts. This would reduce overall variability at nursery exit.

The feed must obviously be consumed to provide any benefit and it takes some piglets more than 24 hours to commence consumption of solid food. The overall objective of this experiment was to optimize the dietary regime fed to piglets immediately post-weaning for greatest overall net return. We focused on adaptation to the solid feed immediately post-weaning.

EXPERIMENTAL PROCEDURES

Diets were formulated to meet or exceed nutrient requirements for piglets of this age and weight (NRC 1998). The "complex" diet included spray-dried whey, plasma and blood meal and fish meal (Table 1).
There were 3 dietary treatment regimes, and 2 weight group treatments. The 3 dietary regimes consisted of a simple or a complex diet offered as. A: Complex diet day 0 – 1, simple diet, day 2-14, B: Complex diet day 0 – 4, simple diet day 5-14, C: Simple diet day 0 – 14. Day 0 is weaning (Table 2). Individual body weight and feed intake was determined on day 0, 2, 4, 7 and 14.

Each week, for 17 weeks, the entire weaning group was weighed and pigs ranked according to body weight within gender. The 24 heaviest and 24 lightest pigs were assigned to a pen, 4 pigs per pen. Pens were then randomly assigned to a treatment. Thus each week there were 6 pens of the heaviest and 6 pens of the lightest pigs and 2 pens per treatment per weight group. Care was taken to ensure that the time between the removal of the piglets from the sow and access to feed in the nursery was the same for all piglets and all weeks.

Video-cameras set up over the pens recorded individual feeder approach which was defined as a pig placing their head over and down into the feeder. Pens were recorded for the 24 hours following each diet change (days 0-1, 1-2, and 4-5). Piglets were numbered on their backs for identification. To accommodate the video-recording, lights were on continuously.

RESULTS AND DISCUSSION

This experiment used approximately 40% of each weaning group; we selected the 20% heaviest and lightest from each weaning group. Light piglets weighed almost 4 kgs less (40 %) than their heavier littermates on day 0 ($P < 0.0001$) and 25% less on day 14 post-weaning ($P < 0.0001$).

Table 1. Experimental diets.

Ingredient, %	**Simple**	**Complex**
Wheat	29.86	24.2
Soymeal	25.00	16.90
Peas	10.00	10.00
Canola Meal[1]	7.80	-
Corn	-	20.00
Corn DDGS	20.00	-
SD Whey	-	14.29
SD Plasma	-	2.50
SD Blood Meal	-	2.50
Menhaden Fishmeal	-	5.00
Canola Oil	2.80	1.75
Limestone	0.85	0.70
Mono Calcium Phosphate	1.15	0.15
PSCI Vitamins	0.60	0.60
PSCI Minerals	0.60	0.60
Salt	0.40	0.25
Lysine HCl	0.385	0.02
L-Threonine	0.245	0.19
DL Methionine	0.09	0.130
LS20	0.10	0.10
Choline Chloride	0.08	0.08
$CuSO_4 * 5H_2O$	0.04	0.04
Analyzed Nutrient Content, %		
Moisture	11.74	11.92
Crude Protein	25.45	25.35
ADF	6.35	4.00
NDF	13.52	11.67
Crude Fat	6.17	4.33
Ca	0.92	0.93
P	0.78	0.68
Mg	0.26	0.20
K	1.03	0.99
Na	0.19	0.33
Cost ($ per tonne, ingredient prices, Nov 2010)	343.17	723.02

Table 2. Dietary regime treatments.

	Feeding Regime	
Treatment	**Complex Diet**	**Simple Diet**
A	Day 0-1	Day 2-14
B	Day 0-4	Day 5-14
C		Day 0 - 14

All piglets lost weight over the first 24 hours following weaning, however, body weight loss was less in the light weight piglets (Table 3). This was true even when body weight loss was expressed as a proportion of body weight [(ADG/d 0 BW)*100) = 2.5 % vs 0.3 % for heavy vs light piglets respectively]. Average daily gain of the light weight piglets was approximately 13 % greater than their heavier litter-mates throughout the trial ($P < 0.0001$). Despite this increased rate of gain, heavier pigs weighed 3.25 kgs more (almost 35 %) than the light-weight pigs at weaning.

Piglets on treatment C, receiving the "simple" diet, lost more BW and had reduced feed intake immediately following weaning (d 0-1) than those on treatments A or B. Switching from the complex to the simple diet on day 4 (treatment B) did not have an adverse effect on gain or feed intake in the following days. During the second week of the experiment, dietary treatment had minimal effects on either feed intake or body weight gain and by day 14, body weight was comparable, regardless of treatment (Table 4).

Table 3. The effect of weaning weight on growth, feed intake and feed conversion efficiency.

		Weaning weight			
Parameter	**Day**	**Heavy**	**Light**	**SEM**	**P-Value**
Weaning wt, kg	0	10.40	6.44	0.07	<0.001
	1	10.15	6.42	0.07	<0.001
	4	10.42	6.76	0.08	<0.001
	7	10.71	7.13	0.10	<0.001
	14	12.73	9.48	0.16	<0.001
ADG, kg/d	0-1*	-0.26	-0.02	0.02	<0.001
	2-4	0.07	0.08	0.00	0.04
	5-14	0.25	0.29	0.01	<0.001
ADFI, kg/d	0-1	0.09	0.13	0.01	<0.001
	2-4	0.13	0.13	0.01	0.14
	5-14	0.32	0.32	0.01	0.81
FCE, G/F	0-1	-5.36	-1.34	0.62	<0.001
	2-4	0.40	0.43	0.10	0.84
	5-14	0.70	0.81	0.02	<0.001

*Interaction between body weight and diet, P = 0.01 (shown in Fig 1)

The light-weight pigs responded more to dietary treatment on day 0 than their heavier litter-mates (Figure 1). In fact, light-weight piglets receiving the complex diet immediately following weaning maintained their body-weight over the initial 24 hours. This contrasts with the light-weight pigs receiving the simple diet and the heavy pigs, receiving either simple or complex diets.

Following weaning, the light-weight piglets immediately began approaching the feeder and throughout the initial 4 days of the experiment visited the feeder more than their heavier litter-mates (Figure 2, Table 5). Feed intake was greater in the light-weight piglets, indicating that these feeder visits did result in feed intake. These pigs were housed, 4 pigs of similar body-weight per pen.

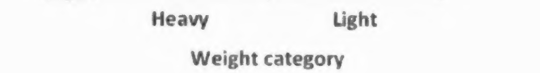

Figure 1. The interaction between weaning weight and feeding regime on the
growth and feed intake of piglets day 0 to 1 post-weaning.Treatment A and B
piglets were receivng the complex diet and treatment C piglets the simple diet
during this period. BW x treatment interaction, P < 0.01, ADG, P < 0.03, ADFI.

During the first 24 hours, the simple diet (trt C) had 20% fewer visits, however this did not approach statistical significance. Switching diets from the complex to the simple (day 1 trt A and day 4, trt C) resulted in a reduction in feeder visits. (Table 6)

CONCLUSION AND IMPLICATIONS

In conclusion, in a non-competitive environment, light-weight piglets can perform equal to their heavier litter-mates. This indicates that environmental factors (feeder access) need to be examined to improve the poor performance of these piglets.

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Table 4. The effect of dietary treatment regime on growth and feed intake of growing pigs.

		Dietary Treatment				
Parameter	**Day**	**A**	**B**	**C**	**SEM**	**P-Value**
Body wt, kg	0	8.43	8.43	8.41	0.07	0.92
	1	8.32	8.32	8.22	0.08	0.07
	4	8.45b	8.90a	8.43b	0.08	<0.001
	7	8.79b	9.18a	8.78b	0.10	<0.001
	14	10.96	11.25	11.10	0.17	0.14
ADG, kg/d	0-1*	-0.11b	-0.12b	-0.20a	0.02	0.002
	2-4	0.03b	0.14a	0.06b	0.01	<0.001
	0-14	0.18	0.20	0.19	0.01	0.14
ADFI, kg/d	0-1	0.12a	0.12a	0.08b	0.01	0.002
	2-4	0.10b	0.17a	0.12b	0.01	<0.001
	0-14	0.24	0.27	0.25	0.01	0.002

*Interaction between body weight and diet, P = 0.01 (shown in Fig 1)

Table 5. The effect of weaning weight on feeder visits.

24 hour period	**Weaning weight group**			**P-Value**	
	Heavy	Light	SEM	Weight	Hour by weight
Day 0	5.61	9.35	0.44	0.08	0.07*
Day 1	6.83	9.28	0.32	0.10	0.07
Day 4	7.37	8.00	0.27	0.007	0.03

*Weaning weight by diet regime, P = 0.05.

Table 6. The effect of dietary regime (Table 2) on feeder visits.

24 hour period	**A**	**B**	**C**	**SEM**	**P-Value**
Day 0	8.13	8.01	6.30	0.55	0.25
Day 1	7.31	9.43	7.41	0.40	0.004
Day 4/5	7.71	8.48	6.87	0.35	0.05

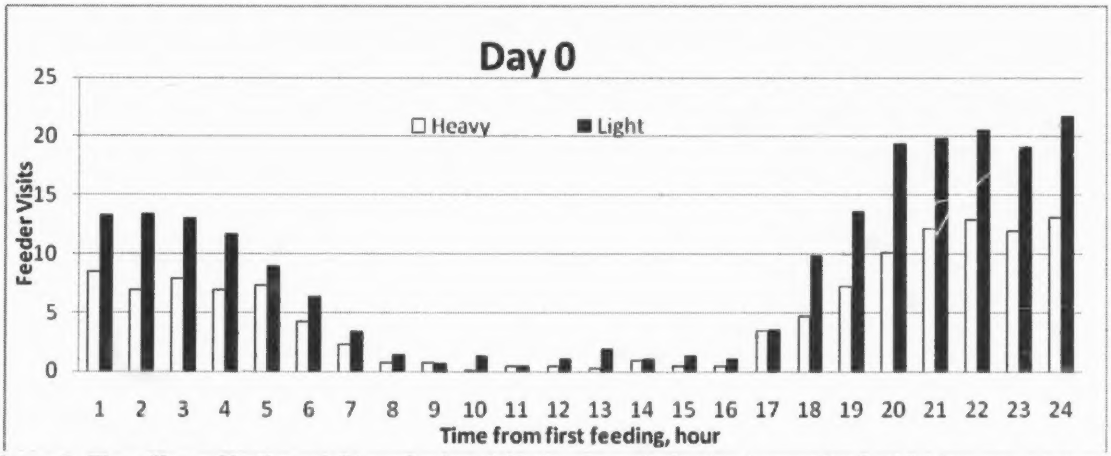

Figure 2. The effect of body weight on feeder visits (per pen, 4 pigs/pen) over the first 24 hours post-weaning.

Evaluation of Water Use and Potential Water Conservation Strategies in Swine Barns

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SUMMARY

Existing water conservation management practices from published literature was identified in this study. In addition, a benchmark survey on actual water use per pig produced in different types of swine operations was conducted. Results from the literature review indicated that animal drinking represented the largest contribution (80%) to total water consumption among all other activities in the barn. The benchmarking survey revealed various options that can be pursued in order to improve water use efficiency in swine operations.

INTRODUCTION

In swine operations, water is used mainly for animal drinking, cooling, cleaning, and domestic use. The rate of water use in the different stages of swine production has impact on the overall production cost and the environment. However, very little effort has been done to document the actual quantity of water used in different production stages and in different types of production units. Thus, this study was aimed to quantify current water usage in swine operations and to evaluate water conservation measures that can be adopted in swine production.

METHODOLOGY

The overall approach of this study was to conduct a comprehensive search of available information on various water conservation practices for livestock operations in various continents, conduct a benchmark survey on actual water use in different types/sizes of swine operations, and evaluate selected water conservation measures in an actual barn facility

The literature review was aimed to gather specific information about existing water conservation practices including their description and effectiveness in reducing water use, economic cost and benefits, and their viability for application to swine production operations in Saskatchewan. Following the literature search was the benchmarking survey in different swine operations across Saskatchewan. The survey was aimed to gather information on water usage, water expenses, and production data for the past three years and consequently, to determine the average yearly water expenses per pig sold ($/pig sold) and per 100-kg sold ($/100-kg pig sold).

RESULTS

A. Highlights of literature review

Previous research conducted in Manitoba swine barns showed that animal drinking represented about 80% of the total water consumption in the barn. The rest was contributed by other activities, namely, animal cooling (10-15%), cleaning (5-10%) and domestic use (1%). In terms of production stages, farrowing stage consumed the greatest amount of water on a per head basis, followed by gestation, grow/ finish, and nursery phases. However, due to the large number of animals involved, combined water use in grow-finish units comprised 64% of the barn's total water use (Froese, 2003). The different water conservation strategies implemented in swine barns that were gathered from published literature are listed in Table 1.

B. Highlights of the survey

Information on 29 participating swine barns in Saskatchewan was collected. The common source of water for the participating barns was barn-owned groundwater well (22 barns), dugout (6 barns) and municipal water system (1 barn). Summarized in Table 2 are the volume of water use per pig sold and the corresponding water expenses, which showed a wide range of values thus presenting an opportunity for savings in terms of water use and reducing spillage. In addition, savings in manure management costs (i.e. hauling/storage/application of manure) can also be achieved.

Table 1. Water conservation strategies for swine barns compiled from published literature.

Category	Water conservation practices
Animal drinking	1. Use of bowl drinkers (push-lever and float types) 2. Use of nipple drinker (swinging and ball-bite) 3. Use of water trough
Cooling pigs/sows	1. Use of evaporative pads 2. Use of intermittent sprayer/mister
Cleaning	1. Use of hot water 2. Use of soap 3. Pre-soaking rooms
Management practices	1. Wastewater recycle for reuse (i.e. pig's drinking water or flushing manure) 2. Adjustment of drinker's height

Table 2. Water usage, water expenses and production data of the 29 participating swine barns.

Operation		# of participating barns	Volume of Water Use		Water Expenses	
Type	Size		Gallons per pig sold	Gallons per 100-kg pig sold	$ per pig sold	$ per 100 kg pig sold
Farrow-to-Finish	12 - 1250 sows	18	67 - 2070	58 - 1558	0.05 - 2.70	0.10-3.19
Farrow-to-Wean	1300 - 6000 sows	3	1907 - 4641	867 - 1856	1.15*	0.46*
Grow-Finish	4500 – 55000 feeders/weanlings	6	164 - 509	207 - 432	NA**	NA
Nursery	23360 – 24000 feeders/weanlings	2	1018 - 1684	3588 - 6122	NA	NA

*data from one barn only
**data not available

Table 3 shows the list of conservation measures and the percentage of participating barns that employed such measures. Almost all barns had pressure washer with straight nozzle attachment. Only few used soap or warm water for cleaning and 76% of the barns pre-soaked the rooms before cleaning. More than half of the participating barns used wet and dry feeder. Few barns used drippers to cool pigs/sows and 45% used spray/mist. Among the drinkers, nipple drinkers were used by most barns; only few used bowls, troughs and ball-bite drinkers. Less than half of the participants adjusted their nipple drinkers as the pigs grow and about 69% regularly inspected pipelines and drinkers for leaks. The rest of the barns fixed any leaks as the problem occurred.

IMPLICATIONS

Current work demonstrated that there are various opportunities to improve water use in swine operations by carefully choosing the right combination of conservation measures and applying these to the areas where highest savings can be achieved. The benchmarking survey also showed that a large percentage of producers currently do not closely monitor the volume of water consumed and the corresponding cost of water used in their production operations. Tracking the water consumption in each stage of production would allow producers to establish water use baseline and help to detect potential problems associated with water wastage.

ACKNOWLEDGEMENTS

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Table 3. List of existing water conservation practices employed in the participating barns.

Water conservation practices	**Percentage of participating barns that employed the measure**
Drinker	
1. Use of nipple drinker (regular standard drinker)	97
2. Use of water trough	34
3. Use of ball-bite drinker	14
4. Use of wet/dry feeder	59
5. Use of bowls/cup drinker	10
Cooling	
1. Use of spray/mist for cooling pigs	45
2. Use of drippers	10
Cleaning (pressure washing)	
1. Use of soap	31
2. Use of warm or hot water	52
3. Pre-soaking rooms	76
Management Practices	
1. Adjustment of nipple drinker's height	41
2. Regular inspection of leaks	69

Effects of Temperament and Floor Space Allowance on Sows at Grouping

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SUMMARY

Many N. American producers are anticipating a change to group housing for sows. The overall purpose of this study was to determine how to reduce the stress of mixing sows by altering space allowance, and social groups. We also studied how space can influence behaviour and aggression within a group. The largest space requirement occurred between midnight and 8am when the highest percentage of sows were lying laterally. From a purely physical perspective the sows would require 1.51m2/sow, however this does not account for any movement or interactions between individuals. When sows were initially grouped, they showed a higher occurrence of injury scores ($P<0.001$) and a greater number of fights ($P<0.001$) compared to the stable groups (3 weeks post-mixing). Most fighting and injuries occurred within 24 hours of mixing. There was not a significant difference between either injury score and number of fights with the different space allowances. Passive/shy shows appeared to show a reduced stress response compared with active/bold sows.

INTRODUCTION

With the announcements in 2007 by the largest producer/packers in both the USA and Canada that they will transition their production facilities to group housing for sows over the next ten years, many producers are anticipating a change to group housing. Previous studies have demonstrated that spacious accommodation reduces the aggression at regrouping and general health during gestation, but the studies did not identify the point at which crowding begins (i.e. space is important, but the specific requirement is unknown). This study was undertaken with the goal of establishing a more precise value. In addition to providing enough space, the temperament of sows was also determined to ascertain if 'shy' or 'passive' sows would be less aggressive than 'bold' or 'active' sows. Specifically, we also wanted to determine the space required to accommodate the postures of sows exhibited over a 24 hr period, the space required to decrease aggression at mixing, space required to accommodate normal behaviour patterns in sows after a stable social structure has been established and to determine if grouping sows with specific behavioural characteristics minimizes the aggression in group housing.

MATERIALS AND METHODS

Sixteen groups of 8 sows were formed based on their behavioural responses to two simple temperament tests (n=128). The groups were either described as being uniform 'passive/shy' or uniform 'active/ bold'. Sows were confined to the loafing area for 23 hours per day and returned to the stalls for feeding. The gestation pens used for the study consisted of 32 walk-in/lock-in stalls and a loafing area. Moveable panels were used to create the required space allowances of 1.6 m2/sow; 2.0 m2/sow; 2.4 m2/sow; and 2.8 m2/sow. Aggressive behaviours were observed live for 4 hours after the sows were initially mixed. Photographs were also taken from mounted cameras at regular intervals for 72 hours post mixing. Injuries were assessed and saliva samples were collected before mixing (baseline) then again at 24 hours and 72 hours post-mixing from 4 focal sows per group. At the end of the 'mixing week', sows were weighed before they were locked into their feeding stalls for one week. At the beginning of the third week, sows entered their new space allowance and stayed there for four weeks, this is referred to as the 'stable weeks'. The sows had their injuries assessed and saliva collected before entering their new space allowance. Live observations of aggressive behaviour were again recorded for 4 hours. Injuries were assessed and saliva samples were also collected again. This same procedure was followed at the end of the four stable weeks. Photographs were taken every 10 minutes for 24 hours at week 1, week 4 and week 10 in order to assess postural behaviour changes over time.

RESULTS AND DISCUSSION

On average, over a 24 hr hour period we observed that 17.2% of sows would be standing, 2.1% sitting, 9.6% lying on sternum, 28% lying relaxed on sternum, and 43.1% lying laterally. These results were consistent over the 'mixed' and 'stable' weeks throughout different stages of gestation (Fig. 1). Using calculations of the total area occupied by sows displaying each of these postures from Ekkel et al, (2003) we calculated how much space would be required for sows over a 24 hour period. The average weight of all the sows involved in the study was

230kg. We used this weight to calculate what the total space requirement would be over 3 different times ever a 24hr period from the postural observations. The 3 periods were 1: midnight – 8am, 2: 8am – 4pm, 3: 4pm – midnight. These space requirements only account for the physical space occupied by sows and does not take the space required for social interactions or free space into consideration. This example shows that sows require the most amount of space between midnight and 8am as this is when the most amount of lateral lying occurs. The least amount of space is used during the day (between 8am and 4pm).

When sows were initially grouped, they showed a higher occurrence of injury scores (P<0.001) (Fig. 2) and a greater number of fights (P<0.001) compared to the stable groups. Most fighting and injuries occurred within 24 hours of mixing, and was consistent across all 4 space allowances (Fig. 3). Sows in the stable groups showed a higher occurrence of threats than the mixed groups. This is likely to be because the aggression would be highest when unfamiliar pigs are first introduced. After a period of time the aggression becomes ritualized (in the form of threats). Threats do not escalate into physical contact due to an established dominance hierarchy. There was not a significant difference between injury score and number of fights with the different space allowances. Grouping sows with different behavioural characteristics does appear to minimize aggression as passive animals had lower injury scores and were involved in less fights, however these results did not indicate a significant difference. Passive animals also had lower cortisol levels (Fig 4), indicating that they may were experiencing less stress than the 'active' sows.

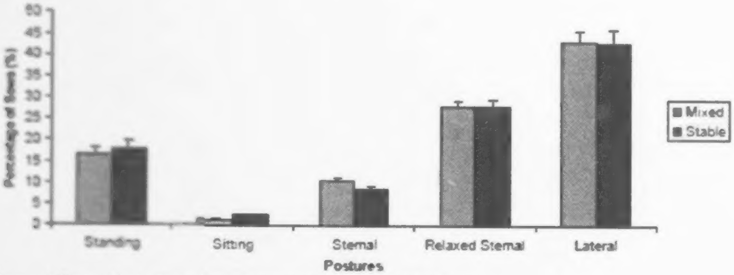

Figure 1: Postural behaviours of sows between 'mixed' and 'stable' phases.

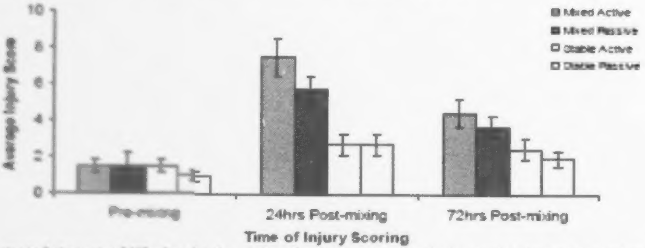

Figure 2: Injury scores of prior to being mixed (0hrs) and 24hrs, 72hrs after being 'mixed' and when 'stable' for both 'active' and 'passive' temperament traits.

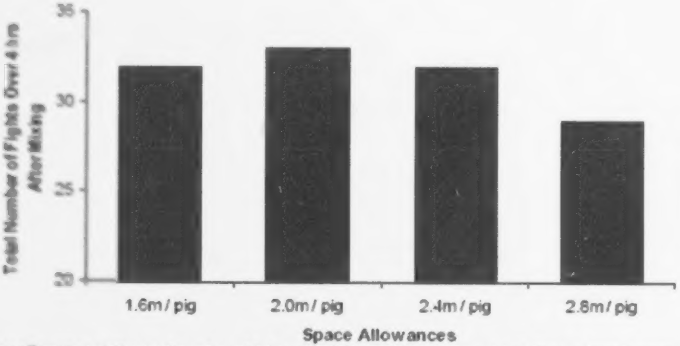

Figure. 3 Effect of space allowance on the total number of fights recorded over 4 hours after mixing. The treatments assessed during the mixing period (first week sows were grouped together) were 4 different space allowances 1.6 m2/sow, 2.0 m2/sow, 2.4 m2/sow, 2.8 m2/sow.

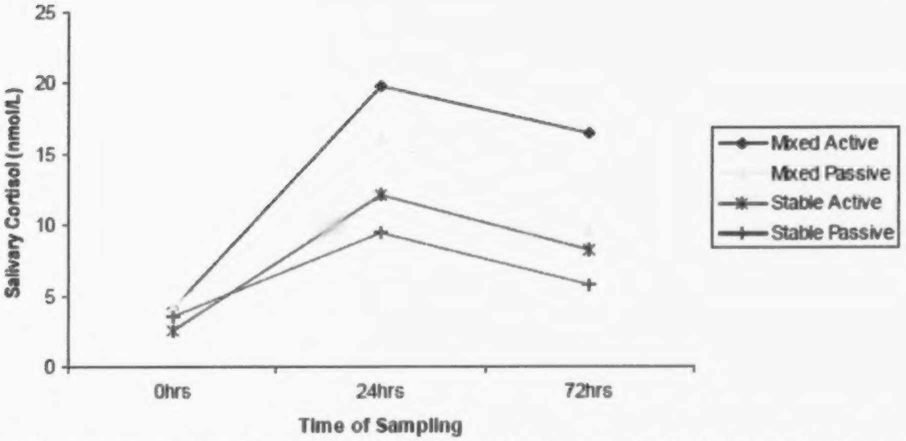

Figure. 4 Salivary cortisol of sows prior to being mixed (0hrs) and 24hrs, 72hrs after being 'mixed' and when 'stable' for both 'active' and 'passive' temperament traits.

CONCLUSION

Aggression and poor control over feed intake of sows in groups are the main reasons for using gestation stalls. Even though these problems still exist in group housing, producers are moving away from stalls and towards groups. Further information is still required to be able to provide advice group housing on to promote the welfare of the sows and the profitability of the producer. Most fighting and injuries occurred within 24hrs of mixing, although no difference was found between space allowances. 'Passive' or 'shy' sows are more likely to be suited to group housing than 'active' or 'bold' sows as they had lower injury scores and had lower levels of salivary cortisol. The walk-in/lock-in stalls used in this study were locked off for 23hrs and only opened for 1hr per day for feeding – similar to a cafeteria system. The results described here specifically relate to this type of group housing and can not necessarily be inferred for other group housing systems.

ACKNOWLEDGEMENTS

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